CHEMICAL HYGIENE PLAN

University of California, Riverside

UC RIVERSIDE | Environmental Health & Safety

Contents

UCR Chemical Hygiene Plan		
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This document replaces UCR Chemical Hygiene Plan version 2024. Summary of changes can be found in Appendix A		

1. Introduction

Purpose

The University of California, Riverside (UCR) is committed to providing a healthy and safe working environment for the campus community, free from recognized hazards in accordance with UC Policy and UCR Policy. The Chemical Hygiene Plan (CHP) establishes a formal written program for protecting laboratory personnel against adverse health and safety hazards associated with exposure to potentially hazardous chemicals and must be made available to all employees working with hazardous chemicals. The CHP describes the proper use and handling practices and procedures to be followed by faculty, staff, students, visiting scholars, and all other personnel working with potentially hazardous chemicals in laboratory settings. This plan is based on best practices identified in, among other sources, "Prudent Practices for Handling Hazardous Chemicals in Laboratories," published by the National Research Council, and the American Chemical Society's "Safety in Academic Chemistry Laboratories" (www.acs.org).

Scope

The CHP applies to personnel within a laboratory where hazardous chemicals are used or stored, or those whose work activities are research-related and involve hazardous chemicals. Use or storage of the hazardous chemicals must be consistent with "laboratory use" to be covered by 8 CCR §5191 and the CHP. "Laboratory use," means that:

- Chemical manipulations are carried out on a "laboratory scale".
- Multiple chemicals or chemical procedures are used.
- Activities are not part of or simulating a production process.
- Protective laboratory practices and equipment are available and in common use.

At a minimum, this definition includes employees who use chemicals in teaching and research laboratories, and in practice this protection is afforded to everyone working in a laboratory setting at UC Riverside.

The CHP does not apply to research involving exclusively radiological materials, radiation producing machines, biological materials, or lasers, as these safety procedures and regulatory requirements are outlined in the Radiation Safety Manual, Manual for Radiation Producing Machines, Biosafety Manual,

and Laser Safety Manual respectively. Research involving more than one type of hazard must comply with all applicable regulatory requirements and follow guidance outlined in the relevant safety manuals.

The information presented in the CHP is not intended to be all-inclusive. Laboratories or work areas engaged in work with potentially hazardous chemicals that have unusual characteristics or are otherwise not sufficiently covered in the written CHP, must have additional procedures, documentation, and training addressing the hazards and how to mitigate their risks, as appropriate. For information on specific chemical safety topics not covered in the CHP, please contact EH&S at: 951-827-5528.

Regulatory Requirements

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

- *Title 8, California Code of Regulations (CCR), Section 5191, "Occupational Exposure to Hazardous Chemicals in Laboratories*
- *Title 8, CCR, Article 110, Section 5200-5220 regulated carcinogens including, but not limited to:*
  - *Section 5203 "Carcinogen Report of Use Requirements"*
  - *Section 5209, "Carcinogens"*
- *Title 8, CCR, Section 5154.1, "Ventilation Requirements for Laboratory – Type Hood Operations"*

Other applicable regulations include those promulgated by the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard"). EH&S will review and evaluate the effectiveness of this Plan at least annually and update it as necessary.

Rights and Responsibilities

Employees and other personnel who work in laboratories have the right to be informed about the potential health hazards of the chemicals in their work areas and to be properly trained to work safely with these substances. This includes custodial staff and other personnel who work to clean and maintain laboratories.

Employees have the right to file a complaint with Cal/OSHA if they feel they are being exposed to unsafe or unhealthy work conditions and cannot be discharged, suspended, or otherwise disciplined by their employer for filing a complaint or exercising these rights. All personnel working with hazardous chemicals are encouraged to report (anonymously, if preferred) any concerns about unsafe work conditions to EH&S at **951-827-5528** or https://ehs.ucr.edu/report.

Responsibilities for the health and safety of the campus community extend to the highest administrative levels at UCR. The Chancellor and Vice Chancellors are responsible for the implementation of the UC's Environmental Health and Safety Policy at all facilities and properties under campus control. Deans and Department Heads are responsible for establishing and maintaining programs in their areas and for providing a safe and healthy work environment.

The day-to-day responsibility for the management of laboratory safety and adherence to safe laboratory practices rests with the PI/Laboratory Supervisor within individual laboratory units' associated departments. All personnel, including PIs/Laboratory Supervisors, employees and students, have a duty to fulfill their obligations with respect to maintaining a safe work environment. Safety is everyone's responsibility.

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

Specific duties and responsibilities of personnel who work in areas where potentially hazardous chemicals are present have been compiled below.

Responsibilities of Principal Investigator (PI), Faculty or other Laboratory Supervisor

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

- ❑ Knowing all applicable health and safety rules and regulations, training and reporting requirements and standard operating procedures associated with chemical safety for regulated substances.
- ❑ Identifying hazardous conditions or operations in the laboratory or other facility containing hazardous chemicals and determining safe procedures and controls, and implementing and enforcing standard safety procedures.
- ❑ Conducting a formal hazard assessment in order to mitigate the hazards found.
- ❑ Establishing standard safety operating procedures (general and protocol specific) and performing literature searches relevant to health and safety for laboratory-specific work.
- ❑ Providing prior-approval for the use of hazardous chemicals in the PI/Laboratory Supervisor's laboratory or other facility with hazardous chemicals.
- ❑ Consulting with EH&S on the use of higher risk materials, such as use of particularly hazardous substances or conducting higher risk experimental procedures, so that special safety precautions may be taken.
- ❑ Maintaining an updated chemical inventory for the laboratory or facility.
- ❑ Ensuring laboratory or other personnel under his/her supervision have access to and are familiar with the appropriate Safety Manual(s).
- ❑ Training all laboratory or other personnel they supervise to work safely with hazardous materials and maintain written records of laboratory-specific or other specialized training in the

appropriate Safety Manual(s). Training must include information on the location and availability of hazard information. EH&S training material can be found at https://ehs.ucr.edu/training

- ❑ Promptly notifying EH&S and/or Facilities Services should he/she become aware that work place engineering controls (e.g., fume hoods) and safety equipment (e.g., emergency showers/eyewashes, fire extinguishers, etc.) become bypassed, disabled or non-operational.
- ❑ Ensuring the availability of all appropriate personal protective equipment (PPE) that properly fits the wearer (e.g., laboratory coats, gloves, eye protection, etc.), training on the selection, care, use, and proper storage, ensuring the PPE is maintained in working order.
- ❑ Promptly reporting accidents and injuries to EH&S at https://ehs.ucr.edu/report. Fatalities and serious injuries MUST be reported to EH&S immediately to allow for compliance with the CAL/OSHA **8-hour** reporting time frame. Any doubt as to whether an injury is serious should favor reporting.
- ❑ Providing funding for exposure monitoring and medical surveillance and/or medical consultation and examination for laboratory and other personnel, as required. Contact the Industrial Hygiene Manager for assistance (https://ehs.ucr.edu/about/directory).
- ❑ Informing facilities personnel, other non-laboratory personnel and any outside contractors of potential laboratory-related hazards when they are required to work in the laboratory environment.
- ❑ Identifying and minimizing potential hazards to provide a safe environment for repairs and renovations.
- ❑ Ensuring that Standard Operating Procedures (SOPs) are written and maintained in the Laboratory Safety Manual

Responsibilities of All Personnel Who Handle Hazardous Chemicals

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

- ❑ Reviewing and following requirements of the CHP and all appropriate Safety Manuals and Policies.
- ❑ Following all verbal and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned.
- ❑ Following the SOP for Pyrophoric Organolithium Reagents when using butyl-lithium
- ❑ Developing good personal chemical hygiene habits, including but not limited to, keeping the work areas safe and uncluttered.
- ❑ Planning, reviewing, and understanding the hazards of materials and processes in their laboratory research or other work procedures prior to conducting work.
- ❑ Utilizing appropriate measures to control identified hazards, including consistent and proper use of engineering controls, personal protective equipment, and administrative controls.
- ❑ Understanding the capabilities and limitations of PPE issued to them.
- ❑ Gaining prior approval from the PI/Laboratory Supervisor for the use of restricted chemicals and other materials.
- ❑ Consulting with the PI/Laboratory Supervisor before using these particularly hazardous substances (PHS), pyrophoric chemicals, explosives and other highly hazardous materials or conducting certain higher risk experimental procedures.

- ❑ Immediately reporting all accidents and unsafe conditions to the PI/Laboratory Supervisor.
- ❑ Completing all required health, safety, and environmental training and providing written documentation to their supervisor.
- ❑ Participating in the medical surveillance program, when required.
- ❑ Informing the PI/Laboratory Supervisor of any work modifications ordered by a physician as a result of medical surveillance, occupational injury or exposure.
- ❑ When working autonomously or performing independent research or work:
  - ❍ Reviewing the plan or scope of work for their proposed research with the PI/Laboratory Supervisor.
  - ❍ Notifying in writing and consulting with the PI/Laboratory Supervisor, in advance, if they intend to significantly deviate from previously reviewed procedures (Note: Significant change may include, but is not limited to, change in the objectives, change in PI, change in the duration, quantity, frequency, temperature or location, increase or change in PPE, change in scale, and reduction or elimination of engineering controls.).
  - ❍ Preparing SOPs and performing literature searches relevant to safety and health that are appropriate for their work.
  - ❍ Providing appropriate oversight, training and safety information to the laboratory or other personnel they supervise or direct.

Responsibilities of the Laboratory Safety Contact

- ❑ Attend a Laboratory Safety Contact orientation meeting provided by EH&S to become familiar with EH&S resources and Research Safety program requirements.
- ❑ Support the PI by helping ensure safety program elements are addressed.
- ❑ Serve as a conduit for information exchange between lab personnel and EH&S in helping to communicate safety and regulatory information.
- ❑ Work with EH&S to coordinate periodic laboratory evaluations conducted by EH&S.
- ❑ Distribute communications about required corrective actions resulting from periodic laboratory evaluations.
- ❑ Engage with EH&S to develop lab-specific and process-specific standard operating procedures (SOPs), and ensure all lab personnel review, sign and comply with SOPs.
- ❑ Report all incidents and near misses to EH&S and facilitate in corrective actions.
- ❑ Inform individuals about the requirements to obtain necessary training as identified by their supervisor, department, college and EH&S. Promote safety, health, and environmental training programs and workshops.
- ❑ Other responsibilities may be delegated as outlined on the Laboratory Safety Contact (LSC) website.

Responsibilities of the EH&S and Chemical Hygiene Officer (CHO)

EH&S is responsible for administering and overseeing institutional implementation of the Laboratory Safety Program. The campus Chemical Hygiene Officer (CHO), Patrick Monnig, is designated by EH&S, and is qualified by training and experience, to provide technical guidance in the development and implementation of the provisions of the CHP. In case of life safety matters or imminent danger to life or health, the Executive Director of EH&S or designee has the authority to order the cessation of the activity

until the hazardous condition is abated. EH&S provides technical guidance to personnel at all levels of responsibility on matters pertaining to laboratory use of hazardous materials. The CHO is a member of EH&S and, with support from other EH&S personnel, is responsible for:

- ❑ Informing PIs/Laboratory Supervisors of all health and safety requirements and assisting with the selection of appropriate safety controls, including laboratory and other workplace practices, personal protective equipment, engineering controls, training, etc.
- ❑ Conducting periodic inspections and immediately taking steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards.
- ❑ Performing hazard assessments, upon request.
- ❑ Helping to develop and implement appropriate chemical hygiene policies and practices.
- ❑ Having working knowledge of current health and safety rules and regulations, training, reporting requirements, and standard operating procedures associated with regulated substances. Such knowledge may be supplemented and developed through research and training materials.
- ❑ Working with research staff to review existing SOPs and assist with developing new SOPs for handling hazardous chemicals.
- ❑ Providing technical guidance and investigation, as appropriate, for laboratory and other types of accidents and injuries.
- ❑ Helping to determine medical surveillance requirements for potentially exposed personnel.
- ❑ Reviewing plans for installation of engineering controls and new facility construction/renovation, as requested.
- ❑ Reviewing and evaluating the effectiveness of the CHP at least annually and updating it as appropriate.

2. Chemical Hazard Communication

Regulatory Requirements

UCR is responsible for providing information about the hazardous substances in our workplace, the associated hazards, and the control of these hazards, through a comprehensive hazard communication program that is summarized below. UCR has an established Hazard Communication Program that complies with the Cal/OSHA Hazard Communication Standard, Title 8 CCR 5194. The purpose of UCR's Hazard Communication Program is to ensure that all employees and, upon request, their personal physicians, have the right to receive information regarding the hazardous substances to which they may have been exposed at work. The requirements of the Hazard Communication Program apply to laboratory environments at UCR due to the potential for large-scale experiments and to activities that may occur outside of areas where engineering controls are available. Proper hazard communication involves the active participation of the PI/Lab Supervisor, the EH&S Chemical Hygiene Officer, and the Laboratory/Facility Safety Coordinator, who are each responsible for providing consultation and safety information to employees working with hazardous chemicals.

List of Hazardous Substances

All labs are required to keep their chemical inventory updated through the https://ehs.ucop.edu/chemicals/ application, and specific information on any associated health or safety

hazards must be made readily available to all laboratory personnel, typically through Safety Data Sheets. Safety Data sheets are also available for any chemical included in a https://ehs.ucop.edu/SDS. Compressed gases need to be included in the chemical inventory.

Hazard Determination

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

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

1. "The Hazardous Substance List", prepared by the Cal/OSHA Director 8CCR339
2. "Toxic and Hazardous Substances, Air Contaminants", 8CCR5155
3. "Threshold Limit Values for Chemical Substances in the Work Environment", ACGIH, 2012;
4. Most Recent "Annual Report on Carcinogens", NTP
5. "IARC Monographs on the Identification of Carcinogenic Hazards to Humans", IARC, WHO
6. SDSs for reproductive toxins and cancer-causing substances https://ehs.ucop.edu/sds
7. "Chemicals Known to the State to Cause Cancer or Reproductive Toxicity" (Proposition 65), 27CCR27001.

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

Safety Data Sheets (SDS)

A SDS must be available for each hazardous substance in a laboratory's chemical inventory. SDSs are available for chemicals entered into a RSS Chemicals inventory on the chemical page, and a general database of chemical SDS is available from the UC online SDS library. PIs/Laboratory Supervisors are responsible for keeping SDSs current and making them available to all laboratory employees throughout the work day. SDSs must be in a central location that can be accessed immediately in the event of an emergency. This can be maintained through the RSS Chemicals application, where for most materials an SDS is automatically linked to any entered chemical, as long as all laboratory employees are able to access the laboratory inventory. Electronic copies may be kept in a file on a group drive, or hard copies maintained in a central location in the laboratory.

New chemical substances synthesized or produced in a laboratory, and used or shared outside of a laboratory suite, require the preparation of an SDS for each synthesized substance.

The Global Harmonization System (GHS) requires the standardization of Safety Data Sheets. The minimum information required for an SDS is:

1. Identification of the substance or mixture and of the supplier
    - GHS product identifier.
    - Other means of identification.
    - Recommended use of the chemical and restrictions on its use.
    - Supplier's details (including name, address, phone number, etc.)

- Emergency phone number.

2. Hazards Identification
   - GHS classification of the substance/mixture and any national or regional information.
   - GHS label elements, including precautionary statements. (Hazard symbols may be provided as a graphical reproduction of the symbols in black and white or the name of the symbol, e.g., flame, skull and crossbones.) Symbols are required to be in a red border/red diamond.
   - Other hazards which do not result in classification (e.g. dust explosion hazard) or are not covered by the GHS.
3. Composition/Information on ingredients
   a. Substance
      - Chemical identity
      - Common name, synonyms, etc.
      - CAS number, EC number, etc.
      - Impurities and stabilizing additives which are themselves classified and which contribute to the classification of the substance.

   b. Mixture
      - The chemical identity and concentration or concentration ranges of all ingredients which are hazardous within the meaning of the GHS and are present at or above their cutoff levels.
4. First aid measures
   - Description of necessary measures, subdivided according to the different routes of exposure, i.e., inhalation, skin and eye contact, and ingestion.
   - Most important symptoms/effects, acute and delayed.
   - Indication of immediate medical attention and special treatment needed, if necessary.
5. Firefighting measures
   a. Suitable (and unsuitable) extinguishing media.
   b. Specific hazards arising from the chemical (e.g., nature of any hazardous combustion products).
   c. Special protective equipment and precautions for firefighters.
6. Accidental release measures
   a. Personal precautions, protective equipment and emergency procedures.
   b. Environmental precautions.
   c. Methods and materials for containment and cleaning up.
7. Handling and storage
   a. Precautions for safe handling.
   b. Conditions for safe storage, including any incompatibilities.
8. Exposure controls/personal protection.
   a. Control parameters, e.g., occupational exposure limit values or biological limit values.
   b. Appropriate engineering controls.
   c. Individual protection measures, such as personal protective equipment.

9. Physical and chemical properties
    a. Appearance (physical state, color, etc.)
    b. Upper/lower flammability or explosive limits
    c. Odor
    d. Vapor pressure
    e. Odor threshold
    f. Vapor density
    g. pH
    h. Relative density
    i. Melting point/freezing point
    j. Solubility(ies)
    k. Initial boiling point and boiling range
    l. Flash point
    m. Evaporation rate
    n. Flammability (solid, gas)
    o. Partition coefficient: n-octanol/water
    p. Auto-ignition temperature
    q. Decomposition temperature
    r. Viscosity
10. Stability and reactivity
    a. Chemical stability
    b. Possibility of hazardous reactions
    c. Conditions to avoid (e.g., static discharge, shock or vibration)
    d. Incompatible materials
    e. Hazardous decomposition products
11. Toxicological information
    a. Concise but complete and comprehensible description of the various toxicological (health) effects and the available data used to identify those effects, including:
        i. Information on the likely routes of exposure (inhalation, ingestion, skin and eye contact);
        ii. Symptoms related to the physical, chemical and toxicological characteristics;
        iii. Delayed and immediate effects and also chronic effects from short- and long-term exposure;
        iv. Numerical measures of toxicity (such as acute toxicity estimates)
12. Ecological information
    a. Eco-toxicity (aquatic and terrestrial, where available)
    b. Persistence and degradability
    c. Bio-accumulative potential
    d. Mobility in soil
    e. Other adverse effects
13. Disposal considerations
    a. Description of appropriate disposal containers to use.
    b. Recommendations of appropriate disposal methods to employ.

c. Description of the physical and chemical properties that may affect disposal activities.
d. Language discouraging sewage disposal.
e. Any special precautions for landfills or incineration activities

14. Transport Information
    a. UN Number
    b. UN Proper shipping name
    c. Transport hazard class(es)
    d. Packing group, if applicable
    e. Marine pollutant (Yes/No)
    f. Special precautions which a user needs to be aware of or needs to comply with in connection with transport or conveyance either within or outside their premises.
15. Regulatory Information
    a. Safety, health and environmental regulations specific for the product in question.
16. Other information including information on preparation and revision of the SDS

Labels, Signs and Other Forms of Warning

Labeling requirements for all hazardous substances are summarized as follows:

- Labels on incoming containers of hazardous chemicals shall not be removed or defaced until the container is completely empty.
- All containers of hazardous materials must be labeled with the identity of the hazardous substance and all applicable hazard warning statements. If abbreviations are used, each room should have a posting listing the abbreviations used, along with the full chemical names. In either case, all containers not actively being used in transfer or a reaction, must be labeled.
- Labels must be legible, in English, and clearly displayed; Lewis structures alone are inadequate.
- The label must contain all applicable hazard warning statements.
- Newly synthesized compounds must be labeled with employee's information and chemical name or structure if known, or at a minimum a chemical identification number derived from the employee's lab-book.
- Non-original containers (e.g., smaller or temporary containers into which a material is transferred for use) must be labeled with the identity of the substance and appropriate hazard warnings.
- Symbols and/or other languages may be provided for non-English speaking employees.
- Prepared mixtures and/or buffers must be labeled with the appropriate hazard warnings based on the knowledge of the chemical and physical properties of that substance.
- Use the symbols in the Globally Harmonized System of Classification and Labeling of Chemicals.

Global Harmonization System (Hazard Communication Standard Pictograms)

Explosive – self-reactive, organic peroxides
Flammable – pyrophoric, self-heating, emits flammable gas, self-reactive, organic peroxides
Oxidizing – Oxidizers
Compressed Gas – gases under pressure
Harmful/Irritant – irritant (skin and eye), skin sensitizer, acute toxicity, narcotic effects, respiratory tract irritant, hazardous to ozone layer (non-mandatory)
Dangerous for the environment – aquatic toxicity
Health Hazard – carcinogen, mutagenicity, reproductive toxicity, respiratory sensitizer, target organ toxicity, aspiration toxicity
Corrosive – skin corrosion/burns, eye damage, corrosive to metals
Toxic – acute toxicity (fatal or toxic)

Employee Information and Training

Employee training on specific workplace hazards must be provided at the time of initial assignment, whenever a new hazard is introduced into the workplace, and whenever employees may be exposed to hazards in other work areas. General Hazard Communication Training is available through EH&S Training. Additional employee training is required whenever a new hazard is introduced into the work environment, and must be provided within 30 days of receiving the SDS or other safety information and before the employee starts with said new hazard. All training must be in the appropriate language,

educational level, and vocabulary for the personnel. Employees must be given the opportunity to ask questions. Please refer to Section 7, Training, for additional information about laboratory training.

UC Laboratory Hazard Assessment Tool (LHAT)

The UC Laboratory Hazard Assessment Tool (LHAT) was developed to broadly identify activities involving chemical and other types of hazards and is an effective method of hazard communication. UC LHAT captures information on the specific type of hazard(s), the location of the hazard(s), the name of the PI/Laboratory Supervisor who oversees the facility and provides guidance for the proper exposure controls (Engineering, Administrative and Personal Protective Equipment (PPE)), that should be used by the laboratory personnel to protect themselves against these hazards. Once the PPE selection is made, the laboratory is required to conduct and document training for laboratory personnel on the use of PPE.

Additional Resources

1. "Occupational Exposure to Hazardous Chemicals in Laboratories." California Code of Regulations Title 8, Section 5191.
2. Standard Operating Procedures (SOPs) for handling toxic chemicals (laboratory specific).
3. General information on the signs and symptoms associated with exposure to hazardous substances used in the laboratory or facility (laboratory specific SOPs or SDS)
    a. Identity labels, showing contents of containers (including waste receptacles) and associated hazards.
    b. Label hazardous waste containers. See the EH&S Waste Management website for hazardous waste management information.
    c. Warnings in areas or around (at/in?) equipment where special or unusual hazards exist (e.g., particularly hazardous substances).
4. Procedures to follow in case of an emergency:
    a. Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers.
    b. Location signs for safety showers, eyewash stations, other safety and first aid equipment, exits and areas where food and beverage consumption and storage are permitted.
    c. Emergency Procedure poster
    d. Report injury, illness, or safety concern online: https://ehs.ucr.edu/report or via Employer's First Report
    e. Work related injury and illness information available online at Risk Management Worker's Compensation

3. Classes of Hazardous Chemicals

Regulatory Requirements

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

- Title 8, CCR, Section 5194, *"Hazard Communication"*
- Title 8, CCR, Section 5209, *"Carcinogens"*

Other applicable regulations include those promulgated by the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard").

Identification & Classification of Hazardous Chemicals

Chemicals can be divided into several different hazard classes. The hazard class will determine how a chemical should be stored and handled and what special equipment and procedures are needed to use them safely.

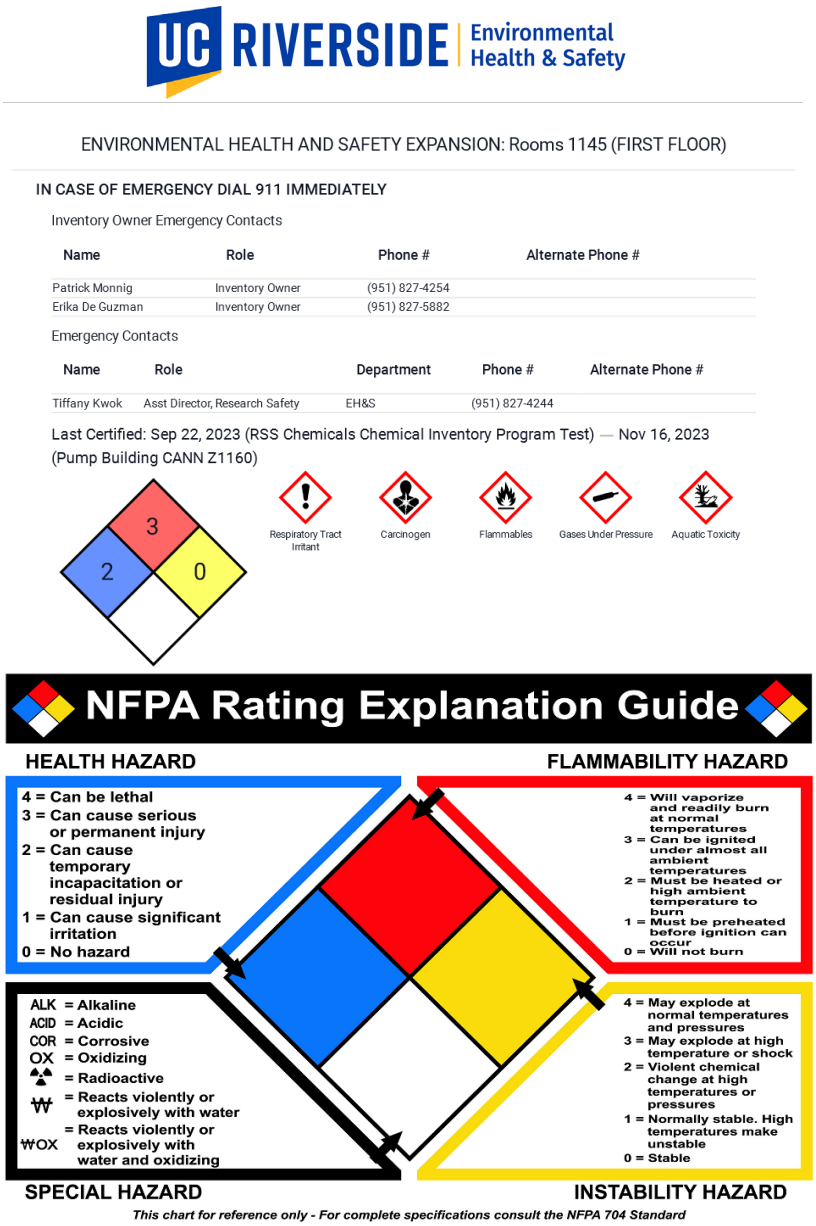
Each chemical container, whether supplied by a vendor or produced in the laboratory, must include labels that clearly identify the hazards associated with that chemical. In addition to specific chemical labels, hazard information for specific chemicals can be found by referencing the Safety Data Sheet (SDS) for that chemical.

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

Rooms containing hazardous chemicals are labeled with a door placard that gives an overview of the key chemical hazards contained within that room.

- Building and Room Information
- Inventory Owner Emergency Contact information
- Emergency Contact information
- Inventory certification date
- Chemical Hazard Information, including an NFPA 704 diamond and GHS symbols

Based on the hazards, the placard may contain the familiar NFPA four color, 1-4 number rating symbol that quickly supplies the hazard information broken down into four hazard classes, with 1 indicating a low level of hazard and 4 indicating a high hazard level. The four chemical hazard types correspond to the four color areas: red indicates a flammability hazard, yellow indicates a reactive hazard, blue indicates a health hazard and the white area is reserved for special hazards that are identified by hazard symbols or labels to indicate hazards such as water reactivity. Each of these hazards has a different set of safety precautions associated with them. The figure below is an example of a UCR placard along with an explanation of the NFPA Rating System.



Example of a UCR Placard

FLAMMABILITY HAZARDS

A number of highly flammable substances are in common use in campus laboratories. Flammable liquids include those chemicals that have a flashpoint of fewer than 200 degrees Fahrenheit (93.33 degrees Celsius). These materials must be stored in self-closing flammable storage cabinets in aggregate quantities of 10 gallons or more per room. If less than 10 gallons, flammables can be stored in regular cabinets. No more than 60 gallons of flammable liquids may be stored inside of an approved flammable liquid storage cabinet. Flame-resistant laboratory coats must be worn when working with large quantities (4 liters or more) of flammable materials and/or with procedures where a significant fire risk is present (e.g., when working with an open flame or near ignition sources) as described in the UCOP policy on Personal Protective Equipment. These materials can constitute a significant immediate threat and should be treated with particular care, even though the use of these materials is fairly common in the laboratory setting. Particular attention should be given to preventing static electricity and sparks

when handling flammable liquids by using electrical grounding and bonding techniques whenever possible.

REACTIVITY HAZARDS

Reactive and explosive substances are materials that decompose under conditions of mechanical shock, elevated temperature, or chemical action, and release large volumes of gases and heat. Some materials, such as peroxide formers, may not be explosive, but may form explosive substances over time. These substances pose an immediate potential hazard and procedures which use them must be carefully reviewed. These materials must also be stored in a separate flame-resistant storage cabinet or, in many cases, in a separate laboratory grade refrigerator or freezer that is designed for flammable/ reactive chemicals. Peroxide formers can only be stored in refrigerators when unopened. Once used, they have to be stored in a dry environment. Pyrophoric chemicals are a special classification of reactive materials that spontaneously combust when in contact with air and require laboratory-specific training. Flame-resistant laboratory coats or other appropriate flame-resistant protection must always be worn when working with pyrophoric chemicals, along with flame-resistant gloves and training as mandated by UCOP policy.

HEALTH HAZARDS

Cal/OSHA uses the following definition for health hazards:

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

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

Corrosive Substances

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

Major classes of corrosive substances include:

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

Symptoms of exposure for inhalation include a burning sensation, coughing, wheezing, laryngitis, shortness of breath, nausea, and vomiting. For eyes, symptoms include pain, blood shot eyes, tearing up, and blurring of vision. For skin, symptoms may include reddening, pain, inflammation, bleeding, blistering and burns. As a physical hazard, corrosive substances may corrode materials they come in contact with and may be highly reactive with other substances. It is important to review information regarding the materials they may corrode, and their reactivity with other substances, as well as

information on health effects. In most cases, these materials should be segregated from other chemicals and require secondary containment when in storage.

Irritants

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

Sensitizer

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

Hazardous Substances with Toxic Effects on Specific Organs

Substances included in this category include:

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

Symptoms of exposure to these materials vary. Personnel working with these materials should review the SDS for the specific material being used, take special note of the associated symptoms of exposure and contact EH&S for assistance.

Particularly Hazardous Substances

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

1. Hazardous chemicals.
2. Particularly hazardous substances.

Substances that pose such significant threats to human health are classified as "particularly hazardous substances" (PHSs). The OSHA Laboratory Standard and Cal/OSHA regulation require that special

provisions be established to prevent the harmful exposure of researchers to PHSs, including the establishment of designated areas for their use.

1. Use of containment devices such as fume hoods or glove boxes;
2. Procedures for safe removal of contaminated waste; and
3. Decontamination procedures.

Particularly hazardous substances are divided into three primary types:

1. Acute Toxic Chemicals
2. Reproductive Toxins
3. Carcinogens

Acute Toxins

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

Reproductive Toxins

Reproductive toxins include any chemical that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

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

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

Carcinogens

Carcinogens are chemical or physical agents that cause cancer. Generally, they are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their

effects may only become evident after a long latency period. Chronic toxins are particularly insidious because they may have no immediately apparent harmful effects. These materials are separated into two classes:

1. Select Carcinogens
2. Regulated Carcinogens

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

- OSHA Carcinogen List
- Annual Report on Carcinogens published by the National Toxicology Program (NTP), including all of the substances listed as "known to be carcinogens" and some substances listed as "reasonably anticipated to be carcinogens" based on the below standard
- IARC Monographs on the Identification of Carcinogenic Hazards to Humans, including all of Group 1 "carcinogen to humans," and some in Group 2A "probably carcinogenic to humans" or 2B, "possibly carcinogenic to humans" based on the below standard
- For substances listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP, to be considered a "select carcinogen" by Cal/OSHA, it must also cause statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
  - after inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3;
  - after repeated skin application of less than 300 mg/kg of body weight per week;
  - after oral dosages of less than 50 mg/kg of body weight per day

Regulated Carcinogens fall into a higher hazard class and can have extensive additional requirements associated with them. Some examples most common to research labs include formaldehyde, methylene chloride, and chromium (VI), and a full list of California regulated carcinogens can be found in Title 8, CCR, Article 110 Regulated Carcinogens. While most carcinogens can be safely used in standard lab environments following guidance in the Chemical Hygiene Plan, carcinogens listed under §5209 Carcinogens require significant additional oversight, and can require laboratory space and equipment modification to legally use. Labs interested in using 5209 carcinogens must consult with EH&S before the chemicals are brought into the lab, and all possible alternatives to their use should be considered. The use of these agents may require personal exposure sampling based on usage. When working with Regulated Carcinogens, it is particularly important to review and effectively apply engineering and administrative safety controls, as the regulatory requirements for laboratories that may exceed long term (8 hours) or short term (15 minutes) threshold values for these chemicals are very extensive.

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, known as "The Proposition 65 List." The list is updated regularly and reviewed by two committees that are a part of the Office of Environmental Health Hazard Assessment's Science Advisory Board. The two committees are the Carcinogen Identification Committee (CIC) and the Developmental and Reproductive Toxicant (DART) Identification Committee.

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 toxicity of nanomaterials merits a cautious approach when working with them.

Nanomaterials include any materials or particles that have an external dimension in the nanoscale (~1-100nm). Nanomaterials are both naturally occurring in the environment and intentionally produced. Intentionally produced nanomaterials are referred to as Engineered Nanomaterials (ENMs). Materials whose properties do not differ significantly between their nanoscale and larger forms are generally excluded from ENMs. The most common types of ENMs are carbon based materials such as nanotubes, metals and metal oxides such as silver and zinc oxide, and quantum dots made of compounds such as zinc selenide (Table 3.1).

Table 3.1 Types of Nanomaterials (from page 5 of Nanotoolkit)

Carbon Based	Buckyballs or Fullerenes, Carbon Nanotubes*, Dendrimers *Often includes functional groups like *PEG (polyethylene glycol), Pyrrolidine, N,N-dimethylethylenediamine, imidazole*
Metals and Metal Oxides	Titanium Dioxide (Titania)**, Zinc Oxide, Cerium Oxide (Ceria), Aluminum oxide, Iron oxide, Silver, Gold, and Zero Valent Iron (ZVI) nanoparticles
Quantum Dots	ZnSe, ZnS, ZnTe, CdS, CdTe, GaAs, AlGaAs, PbSe, PbS, InP *Includes crystalline nanoparticle that exhibits size-dependent properties due to quantum confinement effects on the electronic states (ISO/TS 27687:2008).*

Nanomaterials can be 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 (Table 3.2). 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 or are suspended in volatile solvents or gases. 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).

A detailed Standard Operating Procedure (SOP) for working with nanomaterials should be written to provide guidance on appropriate work practices, engineering controls, personal protective equipment

(PPE), and waste disposal practices depending on the risk level of a particular nanomaterial or process involving a nanomaterial.

For further information, see the California Nanosafety Consortium of Higher Education's "Nanotoolkit: Working Safely with Engineered Nanomaterials in Academic Research Setting", the National Institute of Occupational Safety & Health's (NIOSH) "General Safe Practices for Working with Engineered Nanomaterials in Research Laboratories, and the NIOSH "Current Strategies for Engineering Controls in Nanomaterial Production and Downstream Handling Processes."

Table 3.2 Nanomaterial Risk Categories (from page 10 of Nanotoolkit)

Category 1 Lower Exposure Potential	**Material State** • No potential for airborne release (when handling) • Solid: Bound in a substrate or matrix • Liquid: Water-based liquid suspensions or gels • Gas: No potential for release into air (when handling) **Type of Use** • No thermal or mechanical stress	• Non-destructive handling of solid engineered nanoparticles permanently bonded to a substrate
Category 2 Moderate Exposure Potential	**Material State** • Moderate potential for airborne release (when handling) • Solid: Powders or Pellets • Liquid: Solvent-based liquid suspensions or gels • Gas: Potential for release into air (when handling) **Type of Use** Thermal or mechanical stress induced	• Pouring, heating, or mixing liquid suspensions (e.g., stirring or pipetting), or operations with high degree of agitation involved (e.g., sonication) • Weighing or transferring powders or pellets • Changing bedding out of laboratory animal cages.
Category 3 Higher Exposure Potential	**Material State** • High potential for airborne release (when handling) • Solid: Powders or Pellets with extreme potential for release into air • Gas: Suspended in gas	• Generating or manipulating nanomaterials in gas phase or in aerosol form • Furnace operations • Cleaning reactors • Changing filter elements

		• Cleaning dust collection systems used to capture nanomaterials • High speed abrading/grinding nanocomposite materials

4. How to Reduce Exposures to Hazardous Chemicals

Regulatory Requirements

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

- *Title 8, California Code of Regulations (CCR), Section 5191, "Occupational Exposures to Hazardous Chemicals in Laboratories"*
- *Title 8, CCR, Section 5209, "Carcinogens"*
- *Title 8, CCR, Section 5154.1, "Ventilation Requirements for Laboratory-Type Hood Operations"*

Other applicable regulations include those promulgated by the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard").

Introduction

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

- Inhalation
- Absorption (through the skin or eyes)
- Ingestion
- Injection (skin being punctured by a contaminated sharp object or uptake through an existing open wound)

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

Safety Controls

Safety controls are divided into three main classifications:

1. Engineering Controls
2. Administrative Controls
3. Personal Protective Equipment

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

Engineering Controls

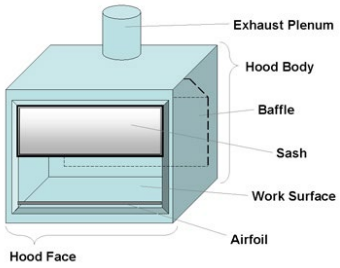
Engineering controls include all “built in” safety systems. These controls offer the first line of protection and are highly effective in that they generally require minimal special procedures or actions on the part of the user except in emergency situations. A fundamental and very common example is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

General Laboratory Ventilation

All laboratory rooms in which hazardous materials are used must have fresh air ventilation with 100% of the exhaust venting to the outside; laboratory rooms should not be part of recycled air systems. In cases where this is not feasible, a formal hazard evaluation will be made by EH&S to determine what work can be done in the space and under what special conditions or limitations. Laboratory rooms should be kept at negative pressure compared to public areas to prevent the spread of hazardous vapors.

Fume Hoods

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



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

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

Air flow for fume hood ventilation is measured at nine points. The average of the nine readings must be at least 100 linear feet per minute (fpm) with a minimum of 70 fpm for any measurement. The average face velocity should not exceed 160 fpm.

Each fume hood must be equipped with at least one type of continuous quantitative monitoring device designed to provide the user with current information on the operational status of the hood. Many hoods also have motion sensors to determine when they are not in active use. These sensors will reduce the fume hood's air flow as part of the campus' energy savings effort. When hazardous materials are in a fume hood, but it is not under active use (e.g., during an unattended reaction or experiment), the sash should be closed. Fume hoods are not designed for storage of hazardous materials.

Routine maintenance and repairs of fume hoods are conducted by Facilities Services. Hood users may request for hood repair directly to Facilities Services using the work order system. Hood users should remove and properly store excess items, and clean the hood surface prior to Facilities Services repairing or providing maintenance to the hood. EH&S or the user may initiate maintenance as well as coordinate with Facilities Services to ensure that it is completed. Upon reported completion by Facilities Services, EH&S will re-inspect the fume hood following maintenance or repairs.

General Rules for Fume Hood Use

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

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

Laboratory fume hoods are one of the most important pieces of equipment used to protect laboratory and other workers from exposure to hazardous chemicals. Chemical fume hoods should be inspected upon installation, renovation, when a deficiency is reported, or a change has been made to the operating characteristics of the hood. Since fume hoods used for some regulated carcinogens have additional requirements, such as increased face velocity, contact EH&S if the intended use changes.

Fume Hood Inspections

1. Physical Inspection
   Evaluate the physical condition of the hood and the materials being used in the hood. This includes checking for:
   - Improper storage of materials inside the fume hood
   - Use of proper materials

- General hood cleanliness
- Physical damage to the fume hood (e.g., broken or cracked sash)
- Fully functioning lighting, fume hood indicator, airflow monitor, and alarm

2. Hood Performance Inspection
   Evaluates the overall hood performance to ensure that it is functioning properly. This involves checking the:
   - Average face velocity and set minimum face velocity, which is used to determine the rating of the hood and what the hood can be used for
   - Noise generated by the fume hood, to ensure it is below 85 dB
   - If fume hood does not pass inspection, a tag will be placed on the sash indicating the reason it failed, and actions to be taken by either EH&S or the lab before using the hood again.

Glove Boxes and Ventilation Devices

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

Another type of ventilation device is the elephant trunk, or snorkel, which is connected to the exhaust system. This device is effective for capturing discharges from instruments such as gas chromatographs, but is not a substitute for working with chemicals in a fume hood. The intake of the snorkel must be placed very close to the source to be effective. There are newer designs that are mounted on articulating arms, which make the systems more convenient to use.

Other Engineering Controls

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

Secondary containment must be provided for corrosive and reactive chemicals and is recommended for all other hazardous chemicals. Secondary containment should be made of chemically resistant materials and should be sufficient to hold at least 110% the volume of at least the largest single bottle stored in the container.

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

Administrative Controls

The next layer of safety controls is Administrative Controls. These controls consist of policies and procedures; they are not generally as reliable as engineering controls in that the user has to carefully follow the appropriate procedures and must be fully trained and aware in order to do so.

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

Standard Operating Procedures

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

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

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

EH&S maintains a website (https://ehs.ucr.edu/) with tools and resources that may be referenced while developing SOPs, including fact sheets for the use of certain hazardous chemicals, online safety videos, and an SOP Library. EH&S is also available to assist with the development of SOPs. SOPs must be developed prior to initiating any experiments with hazardous chemicals or particularly hazardous substances and are to be filed and maintained in the Laboratory Safety Manual where they are available to all laboratory personnel.

When drafting an SOP, consider the type and quantity of the chemical being used, along with the frequency of use. The Safety Data Sheet (SDS) for each hazardous chemical or particularly hazardous

substance that will be addressed in the SOP should be referenced during SOP development. The SDS lists important information that will need to be considered, such as exposure limits, type of toxicity, warning properties, and symptoms of exposure. If a new chemical is produced during the experiment, an SDS will not necessarily be available. In these cases, the toxicity is unknown and it must be assumed that the substance is particularly hazardous, as a mixture of chemicals will generally be more toxic than its most toxic component.

Personal Protective Equipment

Personal protective equipment (PPE) serves as a researcher's last line of defense against chemical exposures and is required by everyone entering a laboratory containing hazardous chemicals.
The UCOP policy on Personal Protective Equipment outlines the basic PPE requirements, which include but are not limited to:

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

The primary goal of basic PPE is to mitigate, at a minimum, the hazard associated with exposure to hazardous substances. In some cases, additional, or more protective, equipment must be used. If a project involves a chemical splash hazard, chemical goggles are required; face shields may also be required when working with chemicals that may cause immediate skin damage. Safety goggles differ from safety glasses in that they form a seal with the face, which completely isolates the eyes from the hazard. If a significant splash hazard exists, heavy gloves, protective aprons and sleeves may also be needed. Gloves should only be used under the specific condition for which they are designed, as no glove is impervious to all chemicals. It is also important to note that gloves degrade over time, so they should be replaced as necessary to ensure adequate protection.

EH&S requires each laboratory to complete a Lab Hazard Assessment prior to beginning work and to provide biannual updates thereafter. PPE can be selected based on this hazard assessment. Lab coats, safety glasses, and splash goggles are provided to researchers by EH&S through the LHAT system. Access the online Lab Hazard Assessment Tool through https://ehs.ucop.edu/. For more information on how to obtain PPE, visit the PPE program website.

How to Use and Maintain PPE

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

Contaminated Clothing/PPE

In cases where spills or splashes of hazardous chemicals on clothing or PPE occur, the clothing/PPE should immediately be removed and placed in a closed container that prevents release of the chemical.

Heavily contaminated clothing/PPE resulting from an accidental spill should be disposed of as hazardous waste. Lightly contaminated laboratory coats should be cleaned and properly laundered, as appropriate. Laboratory personnel should never take contaminated items home for cleaning or laundering. EH&S provides lab coat laundering services for laboratories using EH&S provided PPE, more information is available at https://ehs.ucr.edu/laboratory/ppe#ppe-laundering.

Contact Lenses in the Laboratory

Historically, use of contact lenses in the laboratory has not been recommended. This guidance has changed in recent years, and is outlined in the National Institute for Occupational Health and Safety document Current Intelligence Bulletin 59: Contact Lens Use in a Chemical Environment. There is a lack of injury data indicating that contact lenses use should be restricted, and there can be benefits to wearing contact lenses for laboratory workers, included more options with improved fit for other PPE, such as eye protection and respirators, and better visual acuity. NIOSH recommends "workers be permitted to wear contact lenses provided that the safety guidelines listed here [in Current Intelligence Bulletin 59] are followed and that contact lenses are not banned by regulation or contraindicated by medical or industrial hygiene recommendations." In general, the EH&S guidance for contact lens use in the lab is as follows:

- The PI must ensure that all lab workers are using appropriate eye protection, regardless of contact lens usage. Contact lenses **are not** eye protective devices and wearing them does not reduce the need for eye and face protection.
- The PI and laboratory workers must consult with Safety Data Sheets for chemicals used in the lab to verify that the manufacturer does not recommend against wearing contact lenses.
- The PI has the final authority to determine whether workers in the lab are allowed to wear contact lenses.
- Contact lenses should not be worn in situations where federal OSHA or Cal/OSHA regulations prohibit their use:
    - While working directly with the following chemicals: methylene chloride (dichloromethane), 1,2-dibromo-3-chloropropane, acrylonitrile, ethylene oxide
    - While in a room that stores or uses 4,4-metyhlenedianiline, regardless of whether you are working directly with the chemical

When working in a laboratory while wearing contact lenses:

- Always wear appropriate eye protection such as safety glasses or chemical splash goggles, depending on hazard assessment.
- Maintain proper hand hygiene. Only remove or place contact lenses in a clean environment, after you have washed your hands.
- Remove lenses at the first sign of eye redness or irritation.
- Routinely inspect contact lenses for damage and/or replace them regularly.
- In the event of a chemical eye exposure, do not delay using an eyewash while waiting for contact lens removal. The lens may come out during the eyewash, or can be removed after the eyewash is complete. Delaying eyewash can increase the likelihood of injury or permanent eye damage.

PIs or laboratory workers with questions about the use of contact lenses in chemical environments are encouraged to read the NIOSH recommendations and consult with EH&S.

Respiratory Protection

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

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

Because there are numerous types of respirators available, and each has specific limitations and applications, respirator selection and use requires pre-approval by EH&S. For either required or voluntary use of a respirator, reference the EH&S page on Respiratory Protection, or contact the campus Industrial Hygienist at ehsih@ucr.edu, who will contact the employee to evaluate the potential exposure. The review will include an evaluation of the work area and activities for the following:

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

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

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

- Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator
- What the limitations and capabilities of the respirator are

- How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions
- How to inspect, put on and remove, use, and check the seals of the respirator
- What the procedures are for maintenance and storage of the respirator
- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators
- The general requirements of the respiratory program

Finally, a qualitative or quantitative fit test is conducted by EH&S for each respirator user. The fit test ensures a proper face to face piece seal for each individual and his/her mask. Fit testing is done in accordance with Cal/OSHA regulation Title 8, CCR, Section 5144 "Respiratory Protection."

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

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

Laboratory Safety and Emergency Response Equipment

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

Fire Extinguishers

All laboratories working with combustible chemicals, flammable chemicals, or other potential ignition sources (e.g., lasers) must be outfitted with appropriate fire extinguishers. The Campus Fire Marshal identifies the location of fire extinguishers on campus, and the fire extinguisher for a lab space may be outside of the lab area, such as in the immediate hallway. All extinguishers should be mounted on a wall in an area free of clutter or stored in a fire extinguisher cabinet. Research personnel should be familiar with the location, use and classification of the extinguishers in their laboratory.

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

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

Any time a fire extinguisher is used, no matter for how brief a period, the PI/Laboratory Supervisor, or most senior laboratory personnel present at the time of the incident, must immediately report the incident to the EH&S at 951-827-5528. Fire Extinguisher Training is required annually, and the

EH&S training website contains a Fire Extinguisher training video that provides information on fire extinguisher use.

Safety Showers and Eyewash Stations

All laboratories using hazardous chemicals must have immediate access to safety showers with eye wash stations. Access must be available in an unlocked location within 10 seconds or less for a potentially injured individual and access routes must be kept clear. This requirement applies to all areas where, during routine operations or emergencies, the eyes or body of an employee may come in contact with a substance that could cause corrosion, severe irritation, or permanent tissue damage, or is toxic by absorption. Safety showers must have a minimum clearance of 16 inches from the centerline of the spray pattern in all directions at all times; this means that no objects should be stored or left within this distance of the safety shower.

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

Safety shower/eyewash stations are tested by Facilities Services. Any units which do not have a testing date should be reported immediately to Facilities Services at (951-827-4214). If an eyewash or safety shower needs repair, a work order must be given to Facilities Services. Any questions regarding the procedure for placing a work order should be directed to Facilities Services at (951-827-4214).

Fire Doors

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

Safe Laboratory Habits

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

Personal Protective Equipment:

- Wear closed-toe shoes and full-length pants, or equivalent, at all times when in the laboratory
- Utilize appropriate PPE while in the laboratory and while performing procedures that involve the use of hazardous chemicals or materials
- Confine long hair and loose clothing
- Remove laboratory coats or gloves immediately on significant contamination, as well as before leaving the laboratory
- If planning to wear contacts in the lab, work with supervisor for approval and safety plan.
- Use any other protective and emergency apparel and equipment as appropriate. Be aware of the locations of first aid kits and emergency eyewash and shower stations

Chemical Handling:

- Properly label and store all chemicals. Use secondary containment at all times
- Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan
- Do not smell or taste chemicals
- Never use mouth suction for pipetting or starting a siphon
- Do not dispose of any hazardous chemicals through the sewer system
- Be prepared for an accident or spill and refer to the emergency response procedures for the specific material. Procedures should be readily available to all personnel. For general guidance, the following situations should be addressed:
    - Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention
    - Skin Contact: Promptly flush the affected area with water and remove any contaminated clothing. If symptoms persist after washing, seek medical attention

Equipment Storage and Handling:

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

Laboratory Operations:

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

Food/Drink:

- Do not eat, drink, smoke, chew gum, or apply cosmetics in areas where laboratory chemicals are present; wash hands before conducting these activities

- Do not store, handle, or consume food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations
- Wash areas of exposed skin well before leaving the laboratory

5. Chemical Exposure Assessment

Regulatory Requirements

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

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

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

Additionally, the Safety Drinking Water and Toxic Enforcement Act of 1986 requires Cal/EPA to publish annually a list of Proposition 65 chemicals known to the State to cause cancer or other reproductive toxicity.

Exposure Assessment Overview

All UC employees require protection from exposure to hazardous chemicals above PELs, STELs and Ceiling concentrations. The profession with expertise in exposure assessment monitoring is Industrial Hygiene. At UCR, the person supervising, directing or evaluating the exposure assessment monitoring must be competent in the practice of industrial hygiene. The Safety & Industrial Hygiene Program in EH&S employs personnel with this expertise. General questions regarding exposure assessment or the Industrial Hygiene Program can be directed to EH&S at 951-827-5528.

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

- Based on chemical inventories, review of Standard Operating Procedures (SOPs), types of engineering controls present, laboratory inspection results and/or review of the annual UCR Laboratory Hazard Assessment Tool, EH&S determines whether an exposure assessment is warranted; or
- User of a hazardous chemical has concern or reason to believe exposure is not minimized or eliminated through use of engineering controls or administrative practices (such as transfer of chemical through double needle performed entirely in a fume hood) and the potential for exposure exists. The user should then inform his or her PI/Laboratory Supervisor, who will in turn contact EH&S at 951-827-5528. EH&S will then determine the best course of action in assessing employee exposure, including visual assessment, air monitoring, medical evaluation, examination, or medical surveillance.

In event of any serious injury or exposure, including chemical splash involving dermal or eye contact, immediately call 911 from a campus phone or 951-827-5222 from an off-campus location or cell phone and obtain medical treatment immediately. Do not wait for an exposure assessment to be performed before seeking medical care.

Exposure Assessment Protocol

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

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

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

In assessing exposure to hazardous chemicals for which Cal/OSHA has not published a PEL, STEL, or Ceiling exposure, EH&S defers to the Threshold Limit Values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) or the Recommended Exposure Limits (RELs) established by the National Institute of Occupational Safety & Health (NIOSH). Please contact EH&S at 951-827-5528 for more information regarding these chemicals.

Notification

The Industrial Hygiene Program will promptly notify the employee and his/her PI/Laboratory Supervisor of the results in writing) after the receipt of any monitoring results. EH&S will establish and maintain an accurate record of any measurements taken to monitor exposures for each employee. Records, including monitoring provided by qualified vendors, will be managed in accordance with CCR Title 8 Section 3204 "Access to Employee Exposure and Medical Records."

Exposure Assessment Use to Determine and Implement Controls

EH&S will use any of the following criteria to determine required control measures to reduce employee's occupational exposure:

- Verbal information obtained from employees regarding chemical usage;
- Visual observations of chemical use or laboratory operations;
- Evaluation of existing engineering control measures or administrative practices;
- Recommendations expressed in Safety Data Sheets;
- Regulatory requirements of Cal/OSHA;
- Recommendations from professional industrial hygiene organizations;
- Direct reading instrumentation results;
- Employee exposure monitoring results; and/or
- Medical evaluation, examination and/or surveillance findings.

Particular attention shall be given to the selection of safety control measures for chemicals that are known to be extremely hazardous. Per Cal/OSHA CCR Title 8 Section 5141 "Control of Harmful Exposure to Employees," the control of harmful exposures shall be prevented by implementation of control measures in the following order:

- Engineering controls, whenever feasible

- Administrative controls whenever engineering controls are not feasible or do not achieve full compliance and administrative controls are practical; and
- Personal protective equipment, including respiratory protection, during:
  a. The time period necessary to install or implement feasible engineering controls
  b. When engineering and administrative controls fail to achieve full compliance
  c. In emergencies
  d. As an extra precaution/option for employees

Medical Evaluation

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

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

All work-related medical evaluations and examinations will be performed by a medical facility. Evaluations and examinations will be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

Any laboratory employee or student worker who exhibits signs and symptoms of adverse health effects from work-related exposure should file a Workman's Compensation Claim via Employer's First Report of Injury (EFR).

Information to Provide to the Clinician

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

1. Personal information such as age, weight, and University employee ID number;
2. Common and/or IUPAC name of the hazardous chemicals to which the individual may have been exposed;
3. A description of the conditions under which the exposure occurred;
4. Quantitative exposure data, if available;
5. A description of the signs and symptoms of exposure that the employee is experiencing, if any;
6. A copy of the Safety Data Sheet (SDS) of the hazardous chemical in question;

7. History of exposure including previous employment and non-occupational (recreational) hobbies; and
8. Any additional information helpful in assessing or treating an exposure or injury such as a biological component of exposure or existence of an antitoxin.
9. Pay Status at time of exposure/injury

Physician's Written Opinion

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

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

Confidentiality & Individual's Access to Personal Medical Records

All patient medical information is protected by California and federal law and is considered strictly confidential. The medical facility is prohibited from disclosing any patient medical information that is not directly related to the work-related exposure under evaluation and should not reveal any diagnosis unrelated to exposure. Any patient information disclosed by the medical facility 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 the medical facility 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, the medical facility will otherwise disclose patient medical information only as required by California and Federal law, such as for Worker's Compensation Insurance claims. Each employee has the right to access his/her own personal medical and exposure records. The medical facility 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 hazard. Certain Cal/OSHA standards require clinical examination as part of medical surveillance when exposure monitoring exceeds an established Action Level or PEL.

UCR uses outside vendors for medical surveillance services. Medical surveillance is required of employees who are routinely exposed to certain hazards as part of their job description (such as asbestos) and may be offered to other employees based upon quantifiable or measured exposure. Examples of hazards that are monitored through the medical surveillance program may include: Asbestos, Beryllium, Formaldehyde, Lead, Methylene Chloride, Noise (Hearing Conservation Program),

Radioactive Chemicals (Bioassay Program), Respirator Use (Respirator Protection Program), and other particularly hazardous substances. Individuals with questions regarding work-related medical surveillance are encouraged to contact EH&S at 951-827-5528 for more information.

6. Chemical Inventory, Labeling, Storage and Transportation

Regulatory Requirements

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

- *Title 8, California Code of Regulations (CCR), Section 5164, "Storage of Hazardous Substances"*
- *Title 8, CCR, Section 5191, "Occupational Exposures to Hazardous Chemicals in Laboratories"*
- *Title 8, CCR, Section 5194, "Hazard Communication"*
- *Title 8, CCR, Section 5209, "Carcinogens"*
- *Title 8, CCR, Section 5154.1, "Ventilation Requirements for Laboratory-Type Hood Operations"*
- *Assembly Bill 2286* "An act to amend Section 25404 of the Health and Safety Code, relating to aboveground storage tanks"

Chemical Inventories

Faculty members and other supervisors with chemicals must use the University of California chemical inventory system, RSS Chemicals. RSS Chemicals is used to track what we have and where it is. Reports are generated for various purposes like managing stock, identifying hazards, and complying with reporting requirements.

All primary containers of hazardous materials—solids, liquids, gases, and gels—are to be added to the system. The following information is required for each hazardous material container:

- Group who owns the material
- Material name
- RSS Chemical inventory barcode (exceptions apply)
- Container Size
- Unit (grams, liters, cubic feet, etc)
- Physical state of material
- Container type
- Location
- Concentration of material
- Solvent (if material is a solution)

The campus inventory system uses sublocations to track the environment a container is stored in. The following information is required for each sublocation:

- Building and room
- Sublocation Name
- RSS Chemical inventory barcode
- Temperature

- Pressure

Before ordering chemical containers, review the chemical inventory and purchase the minimum quantities of chemicals necessary for the research project.
When obtaining and removing chemical containers, update the chemical inventory. Access to a chemical's Safety Data Sheet (SDS) can be confirmed through the UC online SDS library.
At least once every 12 months, inventory chemicals and update the chemical inventory system. Annual reviews support safer storage of hazardous materials by identifying items that should be disposed or relocated. Make sure to also add and remove any chemical storage locations.

Where practical, each chemical container should be marked with the receipt and open dates so that expired chemicals can be identified for disposal. Attributes that may indicate that materials need to be disposed of are: cloudiness in liquids, a change in color, evidence of liquids in solids, or solids in liquids, "puddling" of material around outside of containers, pressure build-up within containers, deterioration of containers, and/or exceeding a manufacturer's expiration date.

Information on how to use RSS Chemicals is available on the EH&S Chemical Inventory page. Cal/OSHA Title 8, Section 5194(e)(1) *"Hazard Communication"* requires that employers develop and maintain a list of hazardous chemicals known to the workplace. This is a long-standing regulatory requirement and is an important component of UCR EH&S laboratory safety evaluations. In addition, the California Environmental Reporting System (CERS) requires all regulated businesses to use the internet to electronically submit chemical inventories. Maintenance of the RSS Chemicals inventory allows for safer storage/handling of hazardous materials and compliance with regulatory requirements.

Chemical Labeling

All containers (including diluted chemical solutions and those with abbreviations) of hazardous materials must be labeled with the identity of the hazardous substance and all applicable hazard warning statements or abbreviations. If abbreviations are used, a list of the abbreviations used, the full chemical names and the hazards warning statement associated with each, must be prominently displayed in each room. In either case, all containers not actively being used in transfer or a reaction must be labeled.
Newly synthesized compounds must be labeled with the appropriate hazard warnings based on the knowledge of the chemical and physical properties of that substance.

Labels must be legible, in English, and clearly displayed; Lewis structures alone are inadequate.
Secondary containers (such as spray bottles) must be labeled with the identity of the substance and appropriate hazard warnings.

Symbols and/or other languages may be provided for non-English speaking employees.
Use the symbols in the Globally Harmonized System of Classification and Labeling of Chemicals.

Peroxide forming chemicals (e.g., ethers) must be labeled with a date on the receipt and the date when the bottle is first opened. For containers of peroxide forming chemicals without a manufacturer supplied expiration date, these chemicals are only allowed a one year shelf life and must be disposed of

as waste within one year of receipt or six months of opening. These chemicals can degrade to form shock sensitive, highly reactive compounds and should be stored and labeled very carefully.

Particularly Hazardous Substances require additional labeling to identify the specific hazard associated with each of these chemicals (carcinogen, reproductive toxin, acutely toxicant). In addition, the storage area where they are kept must be labeled with the type of hazard. These chemicals should be segregated from less hazardous chemicals to help with proper access control and hazard identification.

Chemical Storage & Segregation

Establish and follow safe chemical storage & segregation procedures for your laboratory.
Storage guidelines are included for materials that are flammable, oxidizers, corrosive, and water reactive, explosive and highly toxic. For general guidelines on segregation and storage, EH&S has developed a Chemical Segregation Guidance Sheet to assist with developing storage plans for hazardous chemicals. The specific Safety Data Sheet (SDS) should always be consulted when doubts arise concerning chemical properties and associated hazards. All procedures employed must comply with Cal/OSHA, Fire Code, and building code regulations. Always wear appropriate personal protective equipment (e.g., laboratory coat, safety glasses, gloves, safety goggles, apron) when handling hazardous chemicals. Be aware of the locations of the safety showers and emergency eyewash stations. Each laboratory is required to provide appropriate laboratory-specific training on how to use this equipment prior to working with hazardous chemicals. The table below lists chemical safety storage priorities:

Safe Chemical Storage Priorities Table

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

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

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

General Recommendations for Safe Storage of Chemicals

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

The image to the right depicts improper fume hood storage. Chemicals should not be routinely stored on bench tops or stored on the floor. Additionally, bulk quantities of chemicals (i.e., larger than one-gallon) should be stored in a separate storage area, such as a stockroom or supply room.

Laboratory shelves should have a raised lip along the outer edge to prevent containers from falling. The weight of material and its distribution on the shelf should be considered to minimize the potential for shelf collapse. Hazardous liquids, and toxic or corrosive chemicals should not be stored on shelves above eye-level, and chemicals which are highly toxic or corrosive should be in unbreakable secondary containers.

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

Laboratory refrigerators and freezers must be labeled appropriately with “No Food/Drink” and must **never** be used for the storage of food or drinks intended for human consumption. Freezers should be defrosted periodically so that chemicals do not become trapped in ice formations. **Never** store peroxide formers (e.g., ether) in a refrigerator not specifically designed for the storage of flammable liquids.

The California Fire Code sets forth Maximum Allowable Quantities (MAQs) of hazardous chemicals that can be stored in any given area. The exact quantity of a chemical which may be stored varies depending on the class of chemical, the construction of the building it’s in, the floor it’s stored on, and whether it’s stored in a rated cabinet. President Drake has mandated that all UC locations assess their status with respect to MAQ compliance, and develop plans to address any identified issues. EH&S will assist labs in maintaining their inventories in accordance with these limits, and may require review of planned laboratory moves to ensure that these limits are not exceeded. Details regarding MAQ compliance at UCR are available at https://training.ucr.edu/MAQ.

Access to hazardous chemicals, including toxic and corrosive substances, should be restricted at all times. These materials must be stored in laboratories or storerooms that are kept locked when laboratory personnel are not present. Locked storage cabinets or other precautions are always recommended, and

in some cases may be required in the case of unusually toxic or hazardous chemicals. Unusually toxic chemicals may include those that are immediately dangerous to life or health (IDLH). For guidance on storage requirements, please contact EH&S at 951-827-5528.

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

Flammable and Combustible Liquids

In general, flammables should not be stored alongside combustible materials like paper and packaging nylon bags. Large quantities of flammable or combustible materials should not be stored in the laboratory. The Fire Code limits specific volumes of flammable materials or other classes of hazardous chemicals depending on the original design and construction of the facility and varies from building to building at UCR. In most B-occupancy labs, the maximum total quantity of class 1A, 1B, and 1C flammable liquids must not exceed **60 gallons**, which must all be stored in a flammable storage cabinet. The maximum quantity allowed to be kept outside a flammable storage cabinet, safety can, or approved refrigerator/freezer is **10 gallons per room.** Class 1A solvents, such as ethyl ether, should be purchased only in one gallon (4 liter) or smaller containers. Because of the extreme flammability of the Class 1 liquids, only quantities needed for immediate use should be stored. Examples of equipment that can be used for storage include: flammable storage cabinets, flammable storage refrigerators or freezers that are designed and UL approved for the storage of flammable substances, or approved safety cans or drums that are grounded. Always segregate flammable or combustible liquids from oxidizing acids and oxidizers. Flammable materials must never be stored in domestic-type refrigerators/freezers and should not be stored in a refrigerator/freezer if the chemical has a flash point below the temperature of the equipment. Flammable or combustible liquids must not be stored on the floor or in any exit access.

Handle flammable and combustible substances only in areas free of ignition sources and use the chemical in a fume hood whenever practical. Only the amount of material required for the experiment or procedure should be stored in the work area. Always transfer flammable and combustible chemicals from glass containers to glassware or from glass container/glassware to plastic. Transferring these types of chemicals between plastic containers may lead to a fire hazard due to static electricity. The transfer of flammable liquid from 5 gallon or larger metal containers should not be done in the laboratory.

Hazard classification for flammable liquids			
Class	**Flash point**	**Boiling point**	**Examples**
I-A	below 73°F (23°C)	below 100°F (38°C)	diethyl ether, pentane, ligroin, petroleum ether
I-B	below 73°F (23°C)	at or above 100°F (38°C)	acetone, benzene, cyclohexane, ethanol
I-C	73-100°F (24-38°C)	----	p-xylene
Hazard classification for combustible liquids			
II	101-140°F (39-60°C)	----	diesel fuel, motor oil, kerosene, cleaning solvents
III-A	141-199°F (61-93°C)	----	paints (oil base), linseed oil, mineral oil

III-B	200°F (93°C) or above	----	paints (oil base), neatsfoot oil

Pyrophoric & Water Reactive Substances

The use of Pyrophoric materials should be in line with the Pyrophoric Materials Program as managed by EH&S. The basic requirements for pyrophoric material usage are as follows:

1. The laboratory space must meet the requirements for safe use and storage of pyrophoric material. Material must be used and stored in a fully sprinklered building, as approved by the Fire Marshal, and appropriate storage must be available and used.
2. Inventory is regularly managed, and annually certified, using the RSS Chemicals program.
3. An approved SOP must be in place for using pyrophoric materials, signed by the PI and all users of pyrophoric materials in the lab.
4. Users of pyrophoric materials are required to take the Flame Resistant Glove training course in LMS.
5. Users must request flame resistant gloves from EH&S.

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

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

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

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

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

- Dry any new empty containers thoroughly;
- Insert the septum into the neck in a way that prevents atmosphere from entering the clean dry (or reagent filled) flask;
- Insert a needle to vent the flask and quickly inject inert gas through a second needle to maintain a blanket of dry inert gas above the reagent;
- Once the vessel is fully purged with inert gas, remove the vent needle then the gas line. To introduce the excess chemical, use the procedure described in the handling section of the SOP;
- For long-term storage, the septum should be secured with a copper wire or hose clamp
- For extra protection a second same-sized septa (sans holes) can be placed over the first; and
- Use "Parafilm M®" or equivalent around the outer septa and remove the Parafilm M® and outer septum before accessing the reagent through the primary septum.

A template SOP for pyrophoric materials can be found in Appendix A of the Pyrophoric Materials Program.

Oxidizers

Oxidizers (e.g., hydrogen peroxide, potassium dichromate, halogens, nitrate compounds) are chemicals that have the ability to oxidize other substances. Many oxidizing reactions involve the transfer of oxygen atoms, which will contribute to or enhance the combustion of other materials, and react violently when in contact with incompatible materials, making fire conditions more dangerous. Oxidizing agents should be stored in a cool, dry place and kept away from flammable and combustible materials, such as wood, paper, Styrofoam™, most plastics, flammable organic chemicals, and away from reducing agents, such as zinc, alkaline metals, and formic acid. Along with the above storage conditions, oxidizing gases (e.g., oxygen, chlorine, fluorine mixtures) must be stored at least 20 feet away from flammable gases, or separated by a five-foot-high wall with 0.5 hour fire resistance. Oxidizing acids (e.g., nitric acid, perchloric acid, chromic acid) should be stored separately from other acid types. Because of the potential for explosion, reactions involving heating of perchloric acid require the use of a specially designed hood with additional procedures to reduce the risk of a catastrophic explosion, and cannot be performed in normal lab conditions under any circumstances.

Peroxide Forming Chemicals

Peroxide forming chemicals are able to form shock sensitive peroxide crystals. Peroxide crystals can be explosive when concentrated or as solids, which can occur if peroxide forming material is allowed to dry on the outside of a container. Many organic solvents are peroxide formers to some degree:

- Ethers, acetals, and ketals, especially cyclic ethers and those with primary and/or secondary alkyl groups
- Aldehydes, including acetaldehyde and benzaldehyde
- Compounds containing benzylic hydrogens, and
- Compounds containing allylic hydrogens, including most alkenes, vinyl, and vinyldiene compounds and dienes.

Some of the more common peroxide forming chemicals used in research laboratories are tetrahydrofuran (THF), dioxane, diethyl ether, and isopropyl ether. All peroxide forming chemicals 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, highly toxic materials). The containers should be labeled with the date received and the date opened. This information, along with the chemical identity should face forward to minimize container handling during inspection. These chemicals must also be tested and documented for the presence of peroxides periodically. Minimize the quantity of peroxide forming chemicals stored in the laboratory and dispose of peroxide forming chemicals before peroxide formation.

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

If old containers of peroxide forming chemicals are discovered in the laboratory, (greater than two years past the expiration date or if the date of the container is unknown), **do not handle the container**. If crystallization is present in or on the exterior of a container, **do not handle the container**. Even the friction from opening the container could be enough to destabilize peroxide crystals and cause an explosion. Secure the container and contact EH&S at 951-827-5528 for pick-up and disposal.

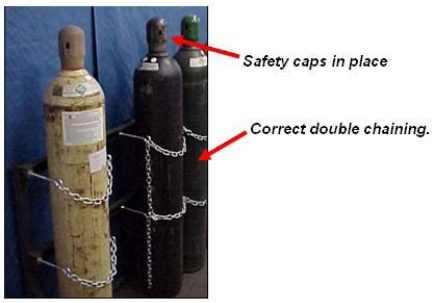
Corrosives

Corrosive materials cause irreversible damage to skin or metals. Store corrosive chemicals (i.e., acids, bases) below eye level and in secondary containers made of chemically resistant materials and sufficient to hold at least 110% the volume of at least the largest single bottle stored in the container. Storage material should be compatible with corrosive materials, such as plastic or powder coated metal. Acids must always be segregated from bases and from active metals (e.g., sodium, potassium, magnesium) at all times and must also be segregated from chemicals which could generate toxic gases upon contact (e.g., sodium cyanide, iron sulfide).

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

Special Storage Requirements

Compressed Gas Cylinders



Cylinders stored and chained correctly

Compressed gas cylinders that are stored in the laboratory must be chained to the wall or other stable building member, with the safety cap in place if not in use. The cylinders must be restrained by two chains; one chain must be placed at one third from the top of the cylinder, and the other placed at one third from the bottom of the cylinder. If this is not practical, contact EH&S for guidance. Bolted "clam shells" may be used in instances where gas cylinders must be stored or used away from the wall. Store liquefied fuel-gas cylinders securely in the upright position.

Cylinders are not to be stored in a horizontal position. Do not expose cylinders to excessive dampness, corrosive chemicals or fumes.

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

Gas cylinder connections must be inspected frequently for deterioration and must never be used without a regulator. **Never** use a leaking, corroded or damaged cylinder and never refill compressed gas cylinders. When stopping a leak between cylinder and regulator, always close the valve before tightening the union nut. The regulator must be replaced with a safety cap when the cylinder is not in use. Move gas cylinders with the safety cap in place using carts designed for this purpose, and do not use carts for storage of cylinders. Please refer to the UCR Compressed Gases Safety Program for more details.

Liquid Nitrogen

Because liquid nitrogen containers are at low pressure and have protective rings mounted around the regulator, they need to be affixed to a permanent fixture such as a wall to prevent them from walking or rolling into the egress path in an earthquake. However, additional protection considerations should be addressed when storing liquid nitrogen in a laboratory. The primary risk to laboratory personnel from liquid nitrogen is skin or eye thermal damage caused by contact with the material. In addition, nitrogen expands 696:1 when changing from a cryogenic liquid to a room temperature gas, so can easily displace large amounts of oxygen in a confined area. The gases usually are not toxic, but if too much oxygen is displaced, asphyxiation is a possibility. Always use appropriate thermally insulated gloves when handling liquid nitrogen. Face shields should be used where splashing can occur, such as during dispensing. Cryogenic Safety training materials are available at https://ehs.ucr.edu/training/library#cryogen-safety.

Laboratory Security

Recently regulatory agencies have been implementing rules to ensure chemical security. While many of these rules are for large manufacturing facilities, it is critical that chemicals be secured to prevent theft

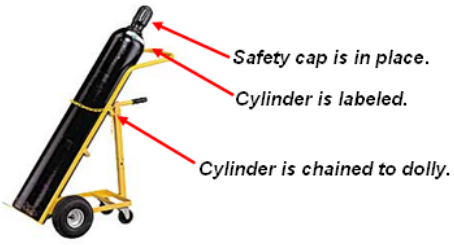
from campus laboratories. Numerous federal agencies are involved in the maintenance of laboratory security, including the Drug Enforcement Agency, Federal Bureau of Investigations, and Department of Homeland Security. It is each laboratory's responsibility to prevent and report any theft of chemicals from their laboratory. Laboratories are encouraged to conduct a Security Value Assessment (SVA). Aspects that should be covered in a SVA include:

- Existing threats, based on the history of the institution (e.g., theft of laboratory materials, sabotage, data security breaches, protests)
- The attractiveness of the institution as a target, and the potential impact of an incident
- Chemicals, biological agents, radioactive materials, or other laboratory equipment or materials with dual-use potential
- Sensitive data or computerized systems
- Animal care facilities
- Infrastructure vulnerabilities (e.g., accessible power lines, poor lighting)
- Security systems in place (e.g., access control, cameras, intrusion detection)
- Access controls for laboratory personnel (e.g., background checks, authorization procedures, badges, key controls, escorted access)
- Institutional procedures and culture (e.g., tailgating, open laboratories, no questioning of visitors)
- Security plans in place
- Training and awareness of laboratory personnel

Labs can increase their security by simply keeping lab doors closed and locked when unoccupied, maintaining a current and accurate chemical inventory, training personnel on security procedures, and controlling access to keys. Labs should report any suspicious activity to UCPD at 951-827-5222 and UCR EH&S at 951-827-5528.

On-Campus Distribution of Hazardous Chemicals

Precautions must be taken when transporting hazardous substances between laboratories. Chemicals must be transported between stockrooms and laboratories in break-resistant, secondary containers such as commercially available bottle carriers made of rubber, metal, or plastic, that include carrying handle(s) and which are large enough to hold the contents of the chemical container in the event of breakage. When transporting cylinders of compressed gases, always secure the cylinder with straps or chains onto a suitable hand truck and protect the valve with a cover cap. Avoid dragging, sliding, or rolling cylinders and use a freight elevator when possible. The figure to the right illustrates correct cylinder transport.



Correct Cylinder Transport

Off Campus Distribution of Hazardous Chemicals

The transportation of hazardous chemicals and compressed gases over public roads, or by air, is strictly governed by international, federal, and state regulatory agencies, including the U.S. Department of

Transportation (DOT) and the International Air Transport Association (IATA). Any person who prepares and/or ships these types of materials must ensure compliance with pertinent regulations regarding training, quantity, packaging, and labeling. **Without proper training and packaging, it is illegal to ship hazardous materials.** Those who violate the hazardous materials shipment regulations are subject to criminal investigation and penalties. UCR Receiving Services has trained personnel to ship hazardous and biological materials. EH&S has trained personnel to ship radioactive materials. Individuals who wish to ship or transport hazardous chemicals, compressed gases or biological materials off-campus, must contact UCR Receiving Services at 951-827-5542. Individuals who wish to ship radioactive materials off-campus must contact EH&S at 951-827-5528.

7. Training

Regulatory Requirements

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

- *Title 8, California Code of Regulations (CCR), Section 5191, "Occupational Exposures to Hazardous Chemicals in Laboratories"*
- *Title 8, CCR, Section 5194, "Hazard Communication"*
- *Title 8, CCR, Section 5209, "Carcinogens"*

Other applicable regulations include those promulgated by the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard").

Introduction

Effective training is critical to facilitate a safe and healthy work environment and prevent laboratory accidents. All Faculty/Other Laboratory Supervisors must participate in formal safety training and ensure that all their employees have appropriate safety training before working in a laboratory. The UCR EH&S Training Program provides both classroom and online training to help meet this requirement.

Types of Training

All laboratory personnel must complete general laboratory safety training and lab-specific training before:

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

Annual refresher training is also required for all laboratory personnel. EH&S offers online training, plus resource materials to assist laboratories in implementing laboratory-specific training.

General Laboratory Safety Training

Anyone working in a laboratory is required to complete Laboratory Safety Fundamentals training which includes:

- Review of laboratory rules and regulations, including the Chemical Hygiene Plan
- Recognition of laboratory hazards
- Use of engineering controls, administrative controls and personal protective equipment to mitigate hazards
- Exposure limits for hazardous chemicals
- Signs and symptoms associated with exposures to hazardous chemicals
- Chemical exposure monitoring
- Review of reference materials (e.g., SDS) on hazards, handling, storage and disposal of hazardous chemicals
- Procedures for disposing of hazardous chemical waste
- Fire safety and emergency procedures
- Information regarding access to employee exposure and medical records, as required annually by 8CCR3204 "Access to Employee Exposure and Medical Records."

All employees (including Faculty (PI's) and Laboratory Supervisors) in laboratories using hazardous materials must complete the following basic laboratory safety online courses via UCR Learning prior to starting work in the laboratory.

- **UC Laboratory Safety Fundamentals (with refresher training every 3 years)**
- **Hazardous Materials and Waste Management (with annual retraining)**
- **Fire Extinguisher (with annual retraining)**
- **Principal Investigator (PI) Responsibilities**

Additional safety training requirements are determined based on the hazards present in the laboratory. For additional information, refer to the "Research Approval and Training Requirement."

Laboratory-Specific Training

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

- Location and use of the Chemical Hygiene Plan, IIPP, SDS(s) and other regulatory information
- Review of IIPP and Emergency Management Plan, including location of emergency equipment and exit routes
- Specialized equipment
- Standard Operating Procedures
- Personal Protective Equipment
- Specialized procedures and protocols
- Particularly Hazardous Substances including physical and health hazards, potential exposure, medical surveillance, and emergency procedures
- It is a University of California policy that each person working in a laboratory or technical area receives a site-specific orientation. Use the *Laboratory Site Specific Training Checklist* to keep track of all provided training.

Resources

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

Online training modules (https://ehs.ucr.edu/training)

- Carcinogen Safety
- Chemical Hygiene Plan
- Electrical Safety Awareness
- Emergency Action Plan
- Ergonomics for the Laboratory
- Fire Extinguishers and Fire Prevention Plan
- Fume Hood Safety
- Hazard Communication
- Hazardous Materials and Waste Management
- Laboratory Audits/Inspections
- Laboratory Safety Orientation
- Safety Data Sheets
- Safety Orientation
- Spill Prevention and Control
- Waste On-Line Tag Program

Spotlight on Safety, Brochures, Posters, Signs, Videos (http://ehs.ucr.edu/resources/)
EH&S provides additional assistance in planning laboratory-specific training upon request.

Documentation of Training

Accurate recordkeeping is a critical component of health and safety training. Per OSHA regulations, departments or laboratories are responsible for documenting health and safety training, including safety meetings, one-on-one training, and classroom and online training. Documentation should be maintained in the Laboratory Safety Manual.

Safety training status for RSS group members can be reviewed by PIs and Lab Safety Delegates at https://ehs.ucop.edu/profile. A training history for all laboratory employees is available to Faculty/Laboratory Supervisors upon request from the UC Learning Center Administrator in Human Resources (www.ucrlearning.ucr.edu). This document can serve as an official record of laboratory safety training conducted by EH&S and others.

8. Lab Evaluations and Compliance

Regulatory Requirements

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

- *Title 8, California Code of Regulations (CCR), Section 5191, "Occupational Exposures to Hazardous Chemicals in Laboratories"*

Other applicable regulations include those promulgated by the U.S. Department of Labor including 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard").

Laboratory Safety Evaluations

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

As part of this laboratory safety program, EH&S conducts periodic inspections of laboratories and other facilities with hazardous chemicals to ensure the laboratory is operating in a safe manner and to ensure compliance with all federal, state, and university safety requirements. The primary goal of lab evaluations is to identify both existing and potential accident-causing hazards, actions, faulty operations, and procedures that can be corrected **before** an accident occurs. UCR policy #425-24 "Environmental Health & Safety - Office Responsibilities and Services" authorizes EH&S to suspend or restrict any operation that "presents a significant (real or potential) imminent hazard associated with life safety, or the health and welfare of campus personnel or the public" until that hazardous condition or activity is abated.

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

- Personal Protective Equipment (PPE)
- Laboratory Practices
- General Safety
- Fire/Life Safety
- Emergency Equipment/First Aid
- Hazard Communications
- Chemicals
- Compressed Gas
- Containment Equipment
- Electrical Safety
- Hazardous Waste
- Biosafety
- Controlled Substances
- Radiation/Lasers
- Approvals/Documents/Manuals/Plans
- Lab Safety Training.

A complete list of checklist questions can be found at https://ehs.ucr.edu/document/labevalchecklist. Once the evaluations are completed, EH&S issues a Laboratory Evaluation Report via UC Inspect. The report identifies deficiencies in the laboratory, both critical and non-critical. Critical deficiencies are those that have the potential to lead to serious injuries or be of critical importance in the event of an emergency. These deficiencies must be **immediately** corrected and have a timeline of 48 hours to correct. Non-critical deficiencies must be corrected within 30-days. Any deficiency that requires a "Facilities Services Work Order" for completion must be added to the Facilities Services Work Order system so that it can be expedited by Facilities Services. Lab personnel should know how to obtain a copy of the most recent Laboratory Evaluation Report. Planned, focused assessments are also conducted.

Examples of these include industrial hygiene assessments and unannounced PPE inspections. For guidance on setting up a safe and successful lab, please reference the PI & Lab Supervisors Checklist.

Notification and Accountability

The laboratory evaluation program requires that Faculty/ Laboratory Supervisors and other responsible parties take appropriate and effective corrective action upon receipt of written notification of evaluation findings. Critical deficiencies, which are deficiencies that have an imminent danger to the health and safety of people working in the lab, are required to be corrected within 48 hours; non-critical deficiencies must be corrected within 30 days. Failure to take corrective actions within the required timeframe will result in an escalation of the notification to the Department Chair, Divisional Dean, Dean, and Vice Chancellors. Depending on the severity of the deficiency, the EH&S Executive Director, in consultation with the Department Chair, Divisional Dean, and Vice Chancellors, may temporarily suspend research activities until the violation is corrected. In some cases, the PI may be required to provide a corrective action plan to the EH&S Executive Director prior to resuming research activities.

RECORDKEEPING REQUIREMENTS

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

- Accident records – 5 years
- Laboratory evaluation reports – 5 years
- Measurements taken to monitor employee exposures – 30 years
- Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations
- Inventory and usage records for high-risk substances should be kept
- Any medical consultation and examinations, including tests or written opinions required by CCR, Title 8, Section 5191 – duration of employment plus 30 years
- Medical records must be retained in accordance with the requirements of state and federal regulations – duration of employment plus 30 years

9. Hazardous Chemical Waste Management

Regulatory Requirements

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

Act, or RCRA. Local enforcement authority is administered by Riverside County Department of Environmental Health and by the local CUPA Riverside Fire Prevention.

Hazardous Waste Program

The EH&S Hazardous Waste Program manages the shipment and disposal of all hazardous waste generated on campus. Each laboratory employee must comply with the campus Hazardous Waste Management Program requirements and all applicable regulations. Hazardous waste pick-up service is provided to all UCR hazardous waste generators in research buildings on campus. Laboratory personnel are responsible for identifying hazardous waste, segregating, labeling, and storing it properly in the laboratory. Laboratory clean-outs and disposal of high hazard compounds must be scheduled at least 3 weeks in advance. The PI/Laboratory Supervisor is responsible for coordinating the disposal of all hazardous materials from his/her laboratories prior to closing down laboratory operations. Review the "*Laboratory/Equipment Relocation & Clearance Program*" document for additional information.

DEFINITION OF HAZARDOUS WASTE

Federal and State regulations define hazardous wastes as a substance which poses a hazard to human health or the environment when improperly managed. A chemical waste is considered hazardous if it is either listed on one of the lists found in Federal or State regulations or if it exhibits one or more of the four following characteristics:

1. **Ignitable** - ignitable wastes generally are liquids with a flash point below 60°C or 140°F (however, just because a material has a higher flash point, it still cannot be drain disposed).
2. **Corrosive** - corrosive wastes are generally aqueous wastes with a pH less than or equal to two (2) or greater than or equal to (12.5). Solutions with pH out of this range have the possibility of being hazardous. Please contact EH&S for clarification.
3. **Reactive** - reactive wastes are those wastes that are unstable, explosive, and capable of detonation or react violently with water.
4. **Toxic** - a chemical that poses a hazard to health or the environment
    a. Has an acute oral LD50 less than 2,500 mg/kg
    b. Has an acute dermal LD50 less than 4,300 mg/kg
    c. Has an acute inhalation LC50 less than 10,000 ppm as a gas or vapor
    d. Has an acute aquatic 96-hour LC50 less than 500 mg/l
    e. Has been shown through experience or testing to pose a hazard to human health or environment because of its ability to cause cancer or mutation (carcinogen, mutagen, teratogen), acute toxicity, chronic toxicity, bio-accumulative properties, or persistence in the environment

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

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

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 (review "Wastes that Require Special Handling").

Extremely Hazardous Waste

Certain compounds meet an additional definition known as "extremely hazardous waste". This list of compounds includes carcinogens, pesticides, and reactive compounds, among others (e.g., formaldehyde, chloroform, and hydrofluoric acid). The Federal EPA refers to this waste as "acutely hazardous waste", but Cal/EPA has published a more detailed list of extremely hazardous waste. Both the State and the Federal lists are included in the EH&S list of extremely hazardous waste. NOTE: While there is some overlap with the list of Particularly Hazardous Substances, the extremely hazardous waste list is specific to hazardous waste management.

Proper Hazardous Waste Management

Training

All personnel who handle, manage or dispose of hazardous waste must complete training **prior** to working with these materials. The EH&S online Hazardous Materials and Waste Management training course covers the hazardous waste program requirements and includes training on container labeling. To complete the Hazardous Materials and Waste Management training, log on to the UCR Learning Center. This training is required annually.

Waste Identification

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

The manufacturer's SDS provides detailed information on each hazardous ingredient in laboratory reagents and other chemical products, and also the chemical, physical, and toxicological properties of that ingredient. The UC SDS library provides an extensive library of research chemicals. Waste streams that have a large percentage of ingredients listed as proprietary information should be discussed with the Hazardous Waste Supervisor.

Labeling

Hazardous waste labels must be placed on the hazardous waste container upon the **start** of accumulation. UCR uses the UC system-wide Waste Accumulation Storage Tracking electronically

(WASTe). Each label must be completed accurately, and updated as the contents of the waste container change. Product names or abbreviations for waste container ingredients should not be used. Information on how to use WASTe can be found in the next section and is available on the EH&S website under Hazardous Waste Pickup.

Waste Accumulation Storage Tracking electronically (WASTe)

How to Create an Account

Waste Accumulation Storage Tracking electronically (WASTe) accounts are integrated with the Laboratory Hazard Assessment Tool (LHAT). Users of LHAT can establish a WASTe account for the laboratory group which they are assigned to. Employees should ascertain if an account has already been established for their PI and associated laboratory(s). If a new account needs to be established, please contact EH&S at 951-827-5528.

How to Use WASTe

Once a user profile has been established, employees can print labels from their laboratory's printer, and then affix the tag to the waste container by sliding it into the plastic envelope provided by EH&S. Each label must be completed accurately, and the tag must be updated as the contents of the waste container change. Product names or abbreviations for waste container ingredients are not allowed. Only the complete name of all constituents is allowed on the WASTe tag. WASTe tags cannot be photocopied, as each tag has a unique bar code that is used to track that individual container. Employees may save a waste profile in the program for waste streams that are frequently generated.

When waste containers approach the maximum allowable storage period in the laboratory accumulation area (180 days), all contacts associated with that WASTe account are emailed a reminder to bring their waste to a scheduled pick-up location or to request a pick-up from EH&S. When EH&S collects the waste, the tags are scanned and the containers are entered into the inventory for the campus waste accumulation area and removed from the laboratory WASTe inventory.

Storage

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

- Hazardous waste containers must be labeled with a WASTe tag at all times
- Waste must be collected and stored at or near the point of generation
- The maximum amount of waste that can be stored in a SAA is 55 gallons of a hazardous waste or 1 quart of **acutely/extremely hazardous waste**. If you reach these volumes for acutely/extremely hazardous waste, then you must have the waste removed within 3 days of reaching these set volumes
- All hazardous waste containers in the laboratory must be kept closed when not in use
- Hazardous waste streams must have compatible constituents, and must be compatible with the containers in which they are stored

- Hazardous waste containers must be stored in secondary containment at all times
- Containers must be in good condition with leak proof lids
- Containers must be less than 80% full
- Dry wastes must be double-bagged in clear, 3-mil plastic bags
- Do not dispose of chemicals by pouring them down the drain or placing them in the trash

Segregation

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

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

Segregation of waste streams should be conducted in a similar manner to segregation of chemical products.

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 cause containers to rupture and explode, resulting in serious injury and property damage. All chemical constituents and their waste byproducts must be compatible for each waste container generated. Waste tags must be immediately updated when a new constituent is added to a mixed waste container, so that others in the laboratory will be aware and manage it accordingly.

Some common incompatible waste streams include:

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

Wastes That Require Special Handling

Unknowns

Unlabeled chemical containers and unknown/unlabeled wastes are considered unknowns, and additional fees must be paid to have these materials analyzed and identified. These containers must be labeled with the word “unknown”. To help prevent this, label all of your products and use a WASTe label as soon as one drop of waste is placed into a container.

Peroxide Forming Chemicals

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

Each container of peroxide forming chemicals should be dated with the date received and the date first opened. There are three classes of peroxide forming chemicals, with each class having different management guidelines. A review of the safety information provided by the manufacturer can be used as a guide to managing PFCs.

Ensure containers of PFCs are kept tightly sealed to avoid unnecessary evaporation, as this inhibits the stabilizers that are sometimes added. Visually inspect containers periodically to ensure that they are free of exterior contamination or crystallization. PFC containers must be disposed of prior to expiration date. If old containers of peroxide forming chemicals are discovered in the laboratory, (greater than two years past the expiration date or if the date of the container is unknown), **do not handle the container**. If crystallization is present in or on the exterior of a container, **do not handle the container**. Secure it and contact the EH&S at 951-827-5528.

Dry Picric Acid

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

If old or previously unaccounted for bottles of picric acid are discovered, **do not touch the container**. Depending on how long the bottle has been abandoned and the state of the product inside, even a minor disturbance could be dangerous. Visually inspect the contents of the bottle without moving it to evaluate its water content and look for signs of crystallization inside the bottle and around the lid. If there is even the slightest indication of crystallization, signs of evaporation, or the formation of solids in the bottle, **do not handle the container** and contact EH&S at 951-827-5528 immediately. Secure the area and restrict access to the container until it can be evaluated by EH&S personnel.

Explosives and Compounds with Shipping Restrictions

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

as explosives (e.g., many nitro- and azo- compounds) will require special packaging and shipping, and may require stabilization prior to disposal. Consult EH&S at 951-827-5528 for disposal considerations of these compounds.

Managing Empty Containers

Empty containers that held Extremely Hazardous waste must be managed as hazardous waste. Do not rinse or reuse these containers.

All other hazardous waste containers, if they are less than 5 gallons in size, should either be reused for hazardous waste collection, or should be cleaned and discarded or recycled. Proper cleaning involves triple rinsing the container, with the first two rinse collected as hazardous waste. Then the labels should be completely defaced (remove it or mark it out completely). Empty containers 5 gallons in size or more should be turned in to EH&S. EH&S has developed a fact sheet as guidance for the handling of empty containers.

Transportation

It is a violation of DOT regulations to transport hazardous waste in personal vehicles, or to carry hazardous waste across campus streets that are open to the public. As a result, EH&S provides pick-up services for all hazardous waste generators. These routine waste pick-ups are for routinely generated research wastes. Special pick-ups and laboratory clean-outs are available upon request.

Accumulation and Disposal

Frequent disposal will ensure that hazardous waste accumulation areas in labs are managed properly, and that accumulation limits are not exceeded. UCR policy states that hazardous chemical waste can be stored in a laboratory for up to 180 days. Once a waste container is 80% full or it is near the 180 day time limit, it should be picked up by EH&S. The Waste Accumulation Storage Tracking electronically (WASTe) should be used to prepare compliant hazardous chemical waste labels as soon as any amount of waste is generated, and to request pickup of hazardous waste.

Hazardous Waste Minimization

UCR is a large quantity generator of hazardous waste. In order to reduce the amount of chemicals that become waste, administrative and operational waste minimization controls can be implemented. Usage of chemicals in laboratory areas should be reviewed to identify practices which can be modified to reduce the amount of hazardous waste generated. In an effort to minimize the costs, health hazards, and environmental impacts associated with the disposal of hazardous waste, below are some guidelines regarding waste minimization:

Purchasing Control: Check your group's online chemical inventory before new products are ordered. When ordering chemicals, be aware of any properties that may preclude long term storage, and order only exact volumes to be used. Using suppliers who can provide quick delivery of small quantities can assist with reducing surplus chemical inventory.
Inventory Control: Rotate chemical stock to keep chemicals from becoming outdated. Identify surplus/unused chemicals and attempt to redistribute these to other users.

Operational Controls: Review your experimental protocol to ensure that chemical usage is minimized. Reduce total volumes used in experiments; employ small scale procedures when possible. Instead of wet chemical techniques, use instrumental methods, as these generally require smaller quantities of chemicals. Evaluate the costs and benefits of off-site analytical services. Avoid mixing hazardous and non-hazardous waste streams. Use less hazardous or non-hazardous substitutes when feasible. Some examples include:

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

Drain Disposal

UCR does not permit drain disposal of chemical wastes, unless a specific dilution and/or neutralization method for a consistent waste stream has been reviewed and approved by EH&S. Drain disposal of properly disinfected infectious or biohazardous liquids is acceptable, if disinfection is conducted as specified by the EH&S Biosafety Program, and the liquids disposed contain no other hazardous constituents.

Bench Top Treatment

Cal/EPA regulations allow some limited bench top treatment of certain chemical waste streams in laboratories, provided that specific procedures are followed. Due to the stringent nature of these requirements, any treatment of hazardous waste in labs must be reviewed and approved by EH&S.

10. Accidents, Emergencies, and Chemical Spills

Overview

Laboratory emergencies may result from a variety of factors, including serious injuries, fires and explosions, spills and exposures, and natural disasters. All laboratory employees should be familiar with and aware of the location of their laboratory's emergency response plans and safety manuals. **Before beginning any laboratory task**, know what to do in the event of an emergency situation. Identify the location of safety equipment, including first aid kits, eye washes, safety showers, fire extinguishers, fire alarm pull stations, and spill kits. Plan ahead and know the location of the closest fire alarms, exits, and telephones in your laboratory. The UCR Emergency Procedure poster provides an overview of emergency response procedures and should be posted in each laboratory. If a copy is needed, please contact EH&S.

For all incidents requiring emergency response, call UCPD at 911 from a campus phone or 951-827-5222 from off-campus or cell phones.

Medical Emergencies

In the event of any medical emergency:

- Check the scene to see that it is safe and that you and the victim are not in danger
- Call UCPD by dialing 9-1-1 from a campus phone or (951) 827-5222 from a cell phone and give the following information:
    - The location of the incident
    - The type of injury or incident

  - If the victim is conscious or unconscious
  - If an ambulance is needed
- If the injury is severe enough to be an emergency, do not leave the scene or attempt to move the injured person from the scene. Moving the injured person from where UCPD knows the person to be can delay care and worsen outcomes.
- Get first aid kit and use as directed or to the level of your first aid training
  - If injury came from chemical exposure or there is a potential for chemical exposure, wear appropriate PPE and do not expose yourself while assisting
- Do not move the victim if unsure about a head or neck injury
- If someone has a foreign object lodged in them, do not remove it
- If there is a chemical exposure as well as an injury, if the person can move themselves to wash the area at the sink or eyewash, have them do so
- Remain calm and reassure the victim while waiting for emergency personnel

Once the area is secured and the scene/victim has been transferred to emergency responder care, notify the PI/Supervisor and report the injury to EH&S using the "Report an Incident or Safety Concern" tool on the ehs.ucr.edu main page or https://ehs.ucr.edu/report. The campus has a requirement to report work related serious injuries to Cal/OSHA within 8 hours of the incident occurring, so the prompt reporting of the incident and relevant details is vital for EH&S to follow up with any required investigation and potential exposure monitoring if the injured had a severe chemical exposure.

Accidents/Injuries that are not Medical Emergencies

PI/Laboratory Supervisors are responsible for ensuring that their employees receive appropriate medical attention in the event of an occupational injury or illness. Information about local medical treatment facilities can be found at https://workerscomp.ucr.edu/medical-treatment-facilities. All accidents and near misses must be reported to the **supervisor and EH&S** at 951-827-5528. An injury, incident or safety concern can also be reported to EH&S online https://ehs.ucr.edu/report. EH&S will conduct an accident investigation and develop recommendations and corrective actions to prevent future accidents. At a minimum, each laboratory must have the following preparations in place:

- Fully stocked first aid kit
- Posting of emergency telephone numbers and locations of emergency treatment facilities
- Training of staff to accompany injured personnel to medical treatment site and to provide medical personnel with copies of SDS(s) for the chemical(s) involved in the incident

UCR Laboratory Safety Rules

1. Familiarize yourself with the lab, location and operation of the safety features (exits, fire extinguishers, safety showers, eye wash facility, and first aid and spill kits) and record this.
2. Complete and record training on all aspects of lab safety relevant to your work prior to beginning potentially hazardous activities and when changes are made to the procedures.
3. Wear appropriate Personal Protective Equipment (PPE), such as: approved gloves, safety glasses or goggles, lab coat or apron, long pants that cover your ankles, and closed-toe shoes that cover

your entire foot. PPE requirements will be designated by the hazards associated with the lab space.

4. Work in properly-ventilated areas and in a safe manner according to Standard Operating Procedures.
5. Do not eat, drink, chew gum, smoke, or apply makeup while working in laboratory spaces where chemical, radioactive, or biological hazards are present.
6. Store all chemicals and other hazardous materials according to California State Law and UCR policy. Know your chemical compatibilities/incompatibilities, stability, shelf life and recommended storage conditions. Refer to Lab Safety Manuals for additional information on working with hazardous materials in a lab.
7. Dispose of all laboratory waste in the correct manner in accordance with UCR policy. There are specific protocols for chemicals, contaminated and broken glass and plastic, sharps, radioactive isotopes and biological agents.
8. Know how to respond properly in an emergency. Clean up all spills safely and promptly, and report them to the PI/Lab Supervisor and EH&S. If unsure how to safely clean up a spill, ask PI/Lab Supervisor or EH&S for assistance.
9. Report to Lab Supervisor and EH&S of all incidents (spills, splashes, fires, etc.), injuries, and accidents, right away, even if the incident seems small or unimportant.
10. Report to PI/Lab Supervisor of any unsafe conditions in the laboratory as soon as possible.

If an employee has a severe or life-threatening injury, call for emergency response at 911. Employees with minor injuries should be treated with first aid kits as appropriate, and sent to the appropriate facility for further evaluation and treatment. After normal business hours, treatment can be obtained at designated medical centers and emergency rooms.

Serious occupational injuries, illnesses, and exposures to hazardous substances must be reported to the supervisor and EH&S at 951-827-5528 within 8 hours. EH&S will report the event to Cal/OSHA, investigate the accident, and complete exposure monitoring, if necessary. Serious injuries include those that result in permanent impairment or disfigurement, or require hospitalization. Examples include amputations, lacerations with severe bleeding, burns, concussions, fractures and crush injuries. As soon as Faculty/Laboratory Supervisors are aware of a potentially serious incident, they must contact EH&S.

Fire-Related Emergencies

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

1. Pull the fire alarm pull station and **call 911 from a campus phone or 951-827-5222** from an off-campus or cell phone to notify the UCPD
2. Evacuate and isolate the area
    1. Use portable fire extinguishers to facilitate evacuation and/or control a small fire (i.e., size of a small trash can), if safe to do so.
    2. If possible, shut off equipment before leaving
    3. Close doors and/or fume hood sash
3. Remain safely outside the affected area to provide details to emergency responders; and

4. Evacuate the building when the alarm sounds. **It is against state law to remain in the building when the alarm is sounding**. If the alarm sounds due to a false alarm or drill, you will be allowed to re-enter the building as soon as the Fire Department determines that it is safe to do so. **Do not go back into the building until the alarm stops and you are cleared to reenter**.
5. **If your clothing catches on fire, go to the nearest emergency shower immediately**. **If a shower is not immediately available, then stop, drop, and roll. A fire extinguisher may be used to extinguish a fire on someone's person.** Report any burn injuries to the supervisor immediately and seek medical treatment. Report to the EH&S at 951-827-5528 within 8 hours every time a fire extinguisher is discharged.

Chemical Spills

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

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

Effective emergency response to these situations is imperative to mitigate or minimize adverse reactions when chemical incidents occur.

Factors to Consider before Spill Clean-Up

1. Size of spill area
2. Quantity of chemical
3. Toxicity
4. Volatility
5. Clean up materials available
6. Training of responders

In the event of a significant chemical exposure or contamination, immediately try to remove or isolate the chemical if safe to do so. When skin or eye exposures occur, remove contaminated clothing and flush the affected area using an eye wash or shower for at least 15 minutes. If a chemical is ingested, follow the instructions on the SDS. Obtain medical assistance as indicated. Remember to wear appropriate PPE before helping others. Faculty/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.

Small chemical spills can be cleaned up by laboratory personnel who have been trained in spill clean-up and with the appropriate materials. A small spill is generally defined as < 1 liter of chemical that is not highly toxic, does not present a significant fire or environmental hazard, and is not in a public area such as a common hallway. **Large chemical spills** include spills of larger quantities, spills of any quantity of highly toxic chemicals, or chemicals in public areas or adjacent to drains. Large spills require emergency response. Call 911 from a campus phone or 95-827-5222 from an off-campus or cell phone for assistance.

What to do with a Small Chemical Spill (<1 Liter)

- Evacuate all non-essential persons from the spill area
- If needed, call for medical assistance by dialing 911 from a campus phone or 951-827-5222 from an off-campus location or cell phone
- Help anyone who may have been contaminated. Use emergency eyewashes/showers to flush the skin or eyes for ***at least 15 minutes***
- Post someone just outside the spill area to keep people from entering. Avoid walking through contaminated areas
- You must have the proper protective equipment and clean-up materials to clean-up spills. Check the chemical's Safety Data Sheet (SDS) in your laboratory or online in the UC SDS library for spill clean-up procedures, or call EH&S at 951-827-5528 for advice
- Turn off sources of flames, electrical heaters, and other electrical apparatus, and close valves on gas cylinders if the chemical is flammable (stop ongoing processes if necessary)
- Confine the spill to a small area. Do not let it spread
- Avoid breathing vapors from the spill. If the spill is in a non-ventilated area (confined space), do not attempt to clean it up. Call for emergency personnel to respond and clean up the spill
- Wear personal protective equipment, including safety goggles, gloves, and a laboratory coat or other protective garment to clean-up the spill (consult with SDS)
- Work with another person to clean-up the spill. Do not clean-up a spill alone

DO NOT ADD WATER TO THE SPILL

Use an appropriate kit to neutralize and absorb inorganic acids and bases. For other chemicals, use the appropriate kit or absorb the spill with sorbent pads, paper towels, vermiculite, dry sand, or diatomaceous earth. For mercury spills and for all other spills requiring specialized clean-up procedures, contact EH&S at 951-827-5528. Collect the residue and place it in a clear plastic bag. Double bag the waste and label the bag with the contents and label it to be picked up as chemical waste.

What to do with a Large Chemical Spill (>1 Liter)

Large chemical spills require emergency response. Call 911 from a campus phone or 951-827-5222 from an off-campus or cell phone. If the spill presents a situation that is immediately dangerous to life or health (IDLH) or presents a significant fire risk, activate a fire alarm, evacuate the area and wait for emergency response to arrive.

- Remove the injured and/or contaminated person(s) and provide first aid
- Call for emergency medical response/medical assistance by dialing 911 from a campus phone or 951-827-5222 from an off-campus phone or cell phone
- Help anyone who may have been contaminated. User emergency eyewash/showers by flushing the skin or eyes for *at least 15 minutes*
- As you evacuate the laboratory, close the door behind you, and:
  - Post someone safely outside and away from the spill area to keep people from entering
  - Confine the spill area if possible and safe to do so
  - Leave on or establish exhaust ventilation
  - If possible, turn off all sources of flames, electrical heaters, and other electrical equipment if the spilled material is flammable

  - Avoid walking through contaminated areas or breathing vapors of the spilled material
- Any employee with known contact with a particularly hazardous chemical must shower, including washing of the hair as soon as possible unless contraindicated by physical injuries

Highly Toxic Chemical Spills

Do not clean up by yourself! All spills of these chemicals require emergency response:

- Any material on The List of Extremely Hazardous Substances
- Aromatic amines
- Bromines
- Carbon disulfide
- Cyanides
- Hydrazine
- Hydrogen Fluoride
- Mercury (if more than a thermometer amount)
- Nitriles
- Nitro-compounds
- Organic halides

Definitions

ACGIH - The American Conference of Governmental Industrial Hygienists is a voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLVs) for hundreds of chemicals, physical agents, and biological exposure indices.
ACTION LEVEL - A concentration designated in Title 8, California Code of Regulations for a specific substance, calculated as an eight (8)-hour time weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.
AEROSOL - Liquid droplets or solid particles dispersed in air that are of fine enough size (less than 100 micrometers) to remain dispersed for a period of time.
ASPHYXIANT - A chemical (gas or vapor) that can cause death or unconsciousness by suffocation. Simple asphyxiants, such as nitrogen, either use up or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.
"C" OR CEILING - A description usually seen in connection with a published exposure limit. It refers to the concentration that should not be exceeded, even for an instant. It may be written as TLV-C or Threshold Limit Value - Ceiling. (See also Threshold Limit Value).
CARCINOGEN - A cancer-producing substance or physical agent in animals or humans. A chemical is considered a carcinogen or potential carcinogen if it is so identified in any of the following:

- National Toxicology Program, "Annual Report of Carcinogens" (latest edition)
- International Agency for Research on Cancer, "Monographs" (latest edition)
- OSHA, 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances

CHEMICAL HYGIENE PLAN - A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment, and work practices that (1) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (2) meets the requirements of OSHA regulation 29 CFR 1910.1450.
COMBUSTIBLE LIQUID - Any liquid having a flashpoint at or above 100°F (37.8°C) but below 200°F (93.3°C) except any mixture having components with flashpoints of 200°F or higher, the total volume of which make up 99% or more of the total volume of the mixture.

COMPRESSED GAS - A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C), or; a gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C), or; a liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM D-32372.

CORROSIVE - A substance that, according to the DOT, causes visible destruction or permanent changes in human skin tissue at the site of contact or is highly corrosive to steel.

DESIGNATED AREA - An area which has been established and posted with signage for work involving hazards (e.g., "select carcinogens," reproductive toxins, or substances which have a high degree of acute toxicity). A designated area may be the entire laboratory, an area of a laboratory, or a device such as a laboratory hood.

EMERGENCY -Any potential occurrence, such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which could result in an uncontrolled release of a hazardous chemical into the workplace.

EXPLOSIVE - A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to a sudden shock, pressure, or high temperature.

FLAMMABLE - A chemical that falls into one of the following categories:

1. Flammable aerosol - an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;
2. Flammable gas - a gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13% by volume or less; or a gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12% by volume, regardless of the lower limit;
3. Flammable liquid - any liquid having a flashpoint below 100°F (37.8°C), except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make up 99% or more of the total volume of the mixture;
4. Flammable solid - a solid, other than a blasting agent or explosive as defined in1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and, when ignited, burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a greater than one-tenth of an inch per second along its major axis.

FLASHPOINT - The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite in the presence of an ignition source or when tested as follows:

1. **Tagliabue Closed Tester** (See American National Standard Method of Test for Flashpoint by Tag Closed Tested, Z11.24-1979 (ASTM D-56-79) for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100oF (37.8°C) or that contain suspended solids and do not have a tendency to form a surface film under test;
2. **Pensky-Martens Closed Tester** (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D-73-79) for liquids with a viscosity equal to or greater than 45 SUS at 100oF (37.8°C), or that contain suspended solids, or that have a tendency to form a surface film under test; or,

3. **Setaflash Closed Tester** (See American National Standard Method of Test for Flashpoint of Setaflash Closed Tester (ASTM D-3278-78)). Organic peroxides, which undergo auto accelerating thermal decomposition, are excluded from any flashpoint determination methods specified above.

GENERAL VENTILATION - Also known as general exhaust ventilation, this is a system of ventilation consisting of either natural or mechanically induced fresh air movements to mix with and dilute contaminants in the workroom air. This is not the recommended type of ventilation to control contaminants that are highly toxic, when there may be corrosion problems from the contaminant, when the worker is close to where the contaminant is being generated, and where fire or explosion hazards are generated close to sources of ignition. (See Local Exhaust Ventilation)

HAZARD ASSESSMENT - A formal procedure undertaken by the supervisor in which occupational hazards for all employees are described per procedure or task, and by affected body part(s) or organ(s), and which is documented and posted in the workplace with all personal protective equipment requirements.

HAZARD WARNING - Any words, pictures, symbols or combination thereof appearing on a label or other appropriate form of warning which convey the hazards of the chemical(s) in the container(s).

HAZARDOUS MATERIAL - Any material which is a potential/actual physical or health hazard to humans.

HAZARDOUS MATERIAL (DOT) - A substance or material capable of posing an unreasonable risk to health, safety, and property when transported including, but not limited to, compressed gas, combustible liquid, corrosive material, cryogenic liquid, flammable solid, irritating material, material poisonous by inhalation, magnetic material, organic peroxide, oxidizer, poisonous material, pyrophoric liquid, radioactive material, spontaneously combustible material, a water-reactive material.

HAZARDOUS CHEMICAL - A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, and neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes or mucous membranes. A chemical is also considered hazardous if it is listed in any of the following:

1. OSHA, 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances;
2. “Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment,” ACGIH (latest edition);
3. “The Registry of Toxic Effects of Chemical Substances,” NIOSH (latest edition)

HIGHLY TOXIC - A substance falling within any of the following categories:

1. A substance that has a median lethal dose (LD50) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each;
2. A substance that has a median lethal dose (LD50) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each; or
3. A substance that has a median lethal concentration (LC50) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

IGNITABLE - A solid, liquid or compressed gas waste that has a flashpoint of less than 140°F. Ignitable material may be regulated by the EPA as a hazardous waste as well.

INCOMPATIBLE - The term applies to two substances to indicate that one material cannot be mixed with the other without the possibility of a dangerous reaction.

IRRITANT - A substance which, by contact in sufficient concentration for a sufficient period of time, will cause an inflammatory response or reaction of the eye, skin, nose or respiratory system. The contact may be a single exposure or multiple exposures. Some primary irritants: Chromic acid, nitric acid, sodium hydroxide, calcium chloride, amines, metallic salts, chlorinated hydrocarbons, ketones and alcohols.

LABEL - Any written, printed or graphic material displayed on or affixed to containers of chemicals, both hazardous and non-hazardous.

LABORATORY TYPE HOOD - A device located in a laboratory, enclosed on five sides with a movable sash or fixed partial enclosure on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

LABORATORY USE OF HAZARDOUS CHEMICALS - Handling or use of such chemicals in which all of the following conditions are met:

1. Chemical manipulations are carried out on a "laboratory scale";
2. Multiple chemical procedures or chemicals are used;
3. The procedures involved are not part of a production process nor in any way simulate a production process; and
4. "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

LOCAL EXHAUST VENTILATION (Also known as exhaust ventilation) – A ventilation system that captures and removes the contaminants at the point they are being produced before they escape into the workroom air. The system consists of hoods, ductwork, a fan, and possibly an air-cleaning device. Advantages of local exhaust ventilation over general ventilation include: It removes the contaminant rather than dilutes it, requires less airflow and, thus, is more economical over the long term; and the system can be used to conserve or reclaim valuable materials; however, the system must be properly designed with the correctly shaped and placed hoods, and correctly sized fans and ductwork.

MEDICAL CONSULTATION - A consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

MIXTURE - Any combination of two or more chemicals if the combination is not, in whole or in part, the result of a chemical reaction.

MUTAGEN - Anything that can cause a change (or mutation) in the genetic material of a living cell.

NFPA - The National Fire Protection Association; a voluntary membership organization whose aims are to promote and improve fire protection and prevention. NFPA has published 16 volumes of codes known as the National Fire Codes. Within these codes is Standard No. 705, "Identification of the Fire Hazards of Materials". This is a system that rates the hazard of a material during a fire. These hazards are divided into health, flammability, and reactivity hazards and appear in a well-known diamond system using from zero through four to indicate severity of the hazard. Zero indicates no special hazard and four indicates severe hazard.

NIOSH - The National Institute for Occupational Safety and Health; a federal agency that among its various responsibilities trains occupational health and safety professionals, conducts research on health and safety concerns, and tests and certifies respirators for workplace use.

ODOR THRESHOLD - The minimum concentration of a substance at which a majority of test subjects can detect and identify the substance's characteristic odor.

OXIDIZER - Is a substance that gives up oxygen easily to stimulate combustion of organic material.

PERMISSIBLE EXPOSURE LIMIT (PEL) - An exposure, inhalation or dermal permissible exposure limit specified in 8CCR5155. PELs may be either a time-weighted average (TWA) exposure limit (8hour), a 15-minute short-term limit (STEL), or a ceiling (C).

PERSONAL PROTECTIVE EQUIPMENT - Any devices or clothing worn by the worker to protect against hazards in the environment. Examples are lab coats, respirators, gloves, and chemical splash goggles.

PHYSICAL HAZARD - A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive), or water-reactive.

PYROPHORIC - A chemical that will spontaneously ignite in the air at a temperature of 130^{o}F (54.4^{o}C) or below.

REACTIVITY - A substance's susceptibility to undergoing a chemical reaction or change that may result in dangerous side effects, such as explosion, burning, and corrosive or toxic emissions. The conditions that cause the reaction, such as heat, other chemicals, and dropping, will usually be specified as "Conditions to Avoid" when a chemical's reactivity is discussed on an MSDS.

REPRODUCTIVE TOXINS - Chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

RESPIRATOR - A device which is designed to protect the wearer from inhaling harmful contaminants.

RESPIRATORY HAZARD - A particular concentration of an airborne contaminant that, when it enters the body by way of the respiratory system or by being breathed into the lungs, results in some body function impairment.

SAFETY DATA SHEET (SDS) - Written or printed material concerning a hazardous chemical which is prepared in accordance with paragraph (g) of 29 CFR 1910.1200. (Formerly material safety data sheet, MSDS)

SELECT CARCINOGENS - Any substance which meets one of the following:

1. It is regulated by OSHA as a carcinogen; or
2. It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or
3. It is listed under Group 1 ("carcinogen to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or
4. It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP.

SENSITIZER - A substance that may cause no reaction in a person during initial exposures, but afterwards, further exposures will cause an allergic response to the substance.

SHORT-TERM EXPOSURE LIMIT - Represented as STEL or TLV-STEL, this is the maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures. Also, the daily TLV-TWA must not be exceeded.

SOLVENT - A substance, commonly water, but in industry or the laboratory often an organic compound, which dissolves another substance.

THRESHOLD LIMIT VALUE (TLV) - Airborne concentration of substances devised by the ACGIH that represents conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLVs are advisory exposure guidelines, not legal standards, which are based on

evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLVs: Time-Weighted Average (TLV-TWA), Short-Term Exposure Limit (TLV-STEL), and Ceiling (TLV-C). (See also PEL).

TOXICITY - A relative property of a material to exert a poisonous effect on humans or animals and a description of the effect and the conditions or concentration under which the effect takes place.

VAPOR - The gaseous form of substances which are normally in the liquid or solid state (at normal room temperature and pressure). Vapors evaporate into the air from liquids such as solvents. Solvents with lower boiling points will evaporate faster.

Appendix A: Summary of Revisions

The following are brief descriptions of revisions to the 2025 UCR Chemical Hygiene Plan, approved in October 2025 by the Research Integrated Safety Committee:

VERSION	REVISION DETAILS	PAGE
2025	**General copy and style editing throughout document, including for clarity and link updating**	
2025	**Added link to Reproductive Health website**	**20**
2025	**Updated chemical inventory guidance to include information required when adding/reviewing containers on RSS Chemicals**	**40**
2025	**Updated chemical inventory guidance to include marking containers with receipt and opened dates**	**41**
2025	**Removed reference to Department of Homeland Security Chemicals of Interest. The Cybersecurity & Infrastructure Security Agency is not enforcing compliance with Chemical Facility Anti-Terrorism Standards at this time.**	**41**
2025	**Moved guidance on access control from chemical inventory to chemical storage section**	**41**
2025	**Added information on Maximum Allowable Quantities (MAQs) and a link to additional reference material on the topic.**	**43**
2025	**Reordered Appendix A in reverse chronological order for clarity**	**72**
2025	**Added Appendix A on EPA requirements for methylene chloride**	**75**
2024	General copy and style editing throughout document, including for clarity and link updating	
2024	Replace information about Lab Safety Officer Responsibility with information on Lab Safety Contact Responsibilities	9
2024	Removed references to defunct ChemCycle program	66
2024	Updated references to incident report for to new short URL: ehs.ucr.edu/report	6, 8, 15, 61
2024	Updated door placard description and visual to new style from RSS Chemicals	16,17
2024	Updated secondary containment information to be consistent with recommendations in Engineering Control guidance	47
2024	Added reference to PPE laundering under How to Use and Maintain PPE	29
2024	Replaced information about hiring PPE laundering companies and replaced with information about EH&S laundering program	30
2024	Added reference to Cryogen Safety training materials.	48
2024	Updated Lab Evaluation Categories to align with current checklist and added link to full checklist.	52

2024	Updated list of people that would be notified of a lab safety evaluation escalation to include vice chancellors rather than Provost.	53
Apr. 2022	General copy and style editing throughout document, including for clarity and link updating	1-69
Apr. 2022	Expanded Scope to include definition of “laboratory use” from CCR 5191	4
Apr. 2022	Added statement about using UC Chemicals to maintain and certify inventory	9
Apr. 2022	Added additional information about the burdens and requirements of 5209 carcinogens	20
Apr. 2022	Removed reference to obsolete Lab Safety Design Manual	24
Apr. 2022	Added note that snorkels are not a substitute for working with chemicals in a fume hood	26
Apr. 2022	Changed LHAT recertification to biannual	28
Apr. 2022	Added statement about fire marshal identifying location and that fire extinguishers may be stored outside of the lab area	31
Apr. 2022	Added statement on not using floors, stairways and hallways as storage areas	33
Apr. 2022	Added statement on storing personal items in the appropriate area	33
Oct.2020	General copy and style editing throughout document, including for clarity and link updating	1-69
Oct.2020	Added information about availability of SDS on UC Chemicals	11
Oct.2020	Added UCOP Flame Resistant Glove requirement for working with pyrophoric chemicals	19
Oct.2020	Revised section on regulated carcinogens, including adding examples and linking to CA code on regulated carcinogens	22
Oct.2020	Added information on what types of PPE are provided by EH&S through LHAT system	30
Oct.2020	Added section “Contact Lenses in the Laboratory” to clarify recommendations on contact lens use. Updated bullet in “Safe Laboratory Habits” about contact lenses.	30,34
Oct.2020	Added link to new Chemical Segregation Guidance Sheet	42
Oct.2020	Added consideration for weight of material on shelf as part of safe storage	43
Oct.2020	Updated section on Pyrophoric & Water Reactive Substances to include information about Pyrophoric Materials Program, and basic requirements for using pyrophoric material on campus	44-46
Oct.2020	Revised section on Oxidizers to give more focused examples and specific storage requirements. Updated requirements on heating perchloric acid.	46

Oct.2020	Revised section on Peroxide Forming Chemicals with more information about the reaction and dangers, give categories of examples and most common examples found in a research laboratory.	46
Oct.2020	Added description of corrosive chemicals, and added that storage container to be compatible with corrosive chemicals	47
Oct.2020	Added line that gas cylinders should not be stored on carts.	48
Oct.2020	Added line on the consequences of high expansion of liquid nitrogen	48
Oct.2020	Added retraining durations for laboratory trainings	50
Oct.2020	Added description of critical deficiencies in a Laboratory Evaluation.	53
Oct.2020	Added retraining requirements for Hazardous Waste Management course.	55
Oct.2020	Added section “Medical Emergencies,” outlining steps to take while responding to a medical emergency	61
Oct.2020	Changed name of section “Accidents” to “Accidents/Injuries that are not Medical Emergencies” to clarify when to use section	61
Oct.2020	Added information on where to find medical treatment facilities for work related injuries	61
Oct.2020	Updated UCR Laboratory Safety Rules to match Nov.2019 revision	62
Oct.2020	Added additional chemicals to the “Highly Toxic Chemical Spills” list	65
Sep.2019	First version reviewed and approved by CHO Patrick Monnig	

Appendix B: Laboratory Chemicals Regulated by the EPA

The United States Environmental Protection Agency (EPA), under the Toxic Substances Control Act (TSCA), has determined that methylene chloride, also known as dichloromethane (DCM), poses an unreasonable risk of injury to health because cumulative exposures to DCM can cause cancer and damage to the liver and kidneys. Acute exposures to high concentrations of DCM vapor in poorly-ventilated spaces has caused central nervous system harm, up to and including unconsciousness and death through respiratory paralysis.

A Workplace Chemical Protection Program is required for those entities that will continue using DCM under these allowable uses. UCR has implemented the following requirements to satisfy this obligation.

Definitions, Roles and Responsibilities

- **As needed monitoring** - Exposure measurements taken when there is a change of use.
- **De minimis** - The threshold concentration for which the regulatory restrictions are not required. For DCM this concentration is 0.01% by weight.
- **Exposure Control Plan (ECP)** - This documents actions taken to mitigate occupational exposures and comply with the WCPP.
- **Owners / operators** - Anyone who owns, leases, operates, controls, or supervises a workplace. This includes UCLA and each PI, instructor, or supervisor who oversees a location where DCM is used or a person who uses DCM. UCR EH&S is responsible for writing and updating this Program. PIs, instructors, and supervisors are responsible for implementing this Program and for approving and enforcing any Exposure Control Plans applicable to their work area.
- **Periodic monitoring** - Dependent upon the results of the initial and/or repeat monitoring; the frequency for gathering new monitoring data ranges from 3 months to 5 years.
- **Potentially exposed person** - Any person who may be exposed to a chemical or mixture in a workplace as a result of a condition of use of that chemical substance or mixture. This applies regardless of whether a person is a user of the chemical or an employee. Potentially exposed persons are responsible for complying with the provisions of this Program.
- **Prohibited Uses** - the EPA has established exposure limits for DCM for ***some*** conditions of use, including “use as a laboratory chemical.” Nearly all other commercial and industrial uses, such as use as a solvent or paint remover, are prohibited. EPA has a full list of prohibited uses in its Guide to Complying with the 2024 Methylene Chloride Regulation.69
- **Regulated area** - An area demarcated where airborne concentrations exceed, or there is a reasonable possibility they may exceed, the Existing Chemical Exposure Limit (ECEL) of 2 ppm or EPA Short Term Exposure Limit (STEL) of 16 ppm.
- **Retailer** - An entity that distributes or makes available products to consumers.
- **Time-Weighted Average (TWA)** - The potentially-exposed person's average airborne exposure in any 8-hour work shift of a 40-hour work week (8-hour TWA), or in any 15-minute reference period covering a specific task where airborne concentrations may instantaneously exceed the full-shift exposure limit (15-minute TWA).
- **Workplace Chemical Protection Program (WCPP)** - A written program to protect potentially exposed persons in the workplace who are engaged in conditions of use that are not prohibited.

Exposure Limits

Under this program, long-term exposures to DCM will be kept below 2 ppm (8-hour TWA) and short-term exposures will be kept below 16 ppm (15-minute TWA). Additional monitoring will be implemented whenever long-term exposures exceed 1 ppm (8-hour TWA). Any deviation from these limits must be approved by the Chemical Hygiene Officer and will be documented in a written Exposure Control Plan. This documentation will include a respiratory protection program to be implemented in work areas receiving a variance.

Exposure Monitoring

Monitoring requirements

Initial monitoring for DCM is required to establish a baseline for DCM users and to inform the development of the Exposure Control Plan (ECP). All initial monitoring shall be conducted by May 5, 2025, or within 30 days after the introduction of DCM in the workplace. Initial monitoring results will be used to determine the frequency of compliance activities such as periodic monitoring. Monitoring must be taken when and where operating conditions are best representative of each potentially exposed person's highest likely full shift and 15-minute exposures occur.

Exemptions to Initial Monitoring

Initial monitoring may not be performed under this Program if exposure to DCM is less than 30 days per year with two conditions:
1) Direct reading measurements must be taken in the environment to ensure levels are below both 1 ppm (8-hour TWA) and 16 ppm (15-minute TWA), and
2) Appropriate controls must be put in place to ensure levels remain below exposure limits.

The Chemical Hygiene Officer must verify in writing that these conditions have been satisfied.

Initial and Periodic Monitoring

The results of initial monitoring will determine how frequently periodic monitoring must occur. Periodic monitoring can range from every 3 months, every 6 months or every 5 years depending on the following conditions:

Measured DCM Concentration (exposure monitoring results)			Re-monitoring Frequency
8-h TWA		**15-min TWA**	
< 1 ppm	and	≤ 16 ppm	8-h TWA and 15-min TWA monitoring at least once every 5 years
< 1 ppm	and	> 16 ppm	8-h TWA monitoring at least once every 5 years AND 15-min TWA monitoring required every 3 months
> 1 ppm & ≤ 2 ppm	and	< 16 ppm	8-h TWA monitoring every 6 months
> 1 ppm & ≤ 2 ppm	and	> 16 ppm	8-h TWA monitoring every 6 months AND immediate suspension of tasks causing the 15-min TWA to exceed 16 ppm in the monitored lab

> 2 ppm	and	> or ≤ 16 ppm	Immediate suspension of use of DCM in the monitored lab

Changes in Conditions

The frequency of periodic monitoring may be reduced if **two consecutive samples** taken at least **7 days apart** show the 8-hour TWA exposure has decreased from between 1 and 2 ppm to below 1 ppm. Lifting of a suspension of DCM use similarly requires that **two consecutive samples** taken at least **7 days apart** show the 8-hour TWA exposure has decreased to below 2 ppm AND that the 15-minute TWA exposure has decreased to below 16 ppm.

Suspension of Periodic Monitoring

Monitoring may be suspended if work with DCM will not occur during the timeframe where monitoring would be required under this plan. In this case, the next use of DCM must be monitored. The PI, instructor, or lab supervisor who oversees the location where DCM is used is responsible for notifying EH&S in advance, and may not proceed with use of DCM until monitoring has been scheduled.

Sampling Requirements

The following sampling guidelines must be followed for every potentially exposed person:

1. Sampling requirements
    a. Sampling must be conducted for every potentially exposed person or a representative sample representing all exposed persons.
    b. Sampling must be taken when and where the operating conditions are representative of full shift exposures.
    c. All workers must be given the opportunity to observe exposure monitoring
    d. Must be taken at the personal breathing zone
    e. Notification of monitoring results to monitored person and potentially exposed persons (e.g., similar exposure group) within 15 working days after receipt of results

2. Sampling Report:
    a. Provide the ECEL, action level, EPA STEL, and significance of each.
    b. Provide the quantity, location, and manner of DCM use at the time of monitoring.
    c. Provide the monitoring results
    d. Whether the concentration exceeds the ECEL, action level, and EPA STEL.
    e. A description of actions taken to reduce exposure to below exposure limits.
    f. A description of the respiratory protection measures if needed
    g. Any identified releases of DCM during monitoring

Regulated Areas

A regulated area must be established wherever airborne concentrations of DCM exceed, or could reasonably be expected to exceed, the ECEL of 2 ppm or STEL of 16 ppm based on monitoring. Regulated areas are only allowed by variance under this Program, with additional required controls as outlined below.

Establishing Regulated Areas

Regulated areas must be established and clearly demarcated by signage indicating use of DCM in the area. Signage serves to alert potentially exposed persons of the boundaries of the area and minimizes the number of exposed persons.

The exact wording will be tailored for each area, and may be in multiple languages as needed. An example of acceptable wording is the following:

Methylene Chloride Warning
Authorized Personnel Only
Airborne Concentrations may exceed:
ECEL: 2 ppm
STEL: 16 ppm
Avoid Exposure
Follow Safety Protocols
Respiratory Protection Required When Methylene Chloride is in Use

Access Control

Only authorized personnel may enter a regulated area. These personnel must receive DCM-specific training, including hazard communication, safe handling practices, emergency procedures, and proper use of PPE prior to entering the regulated area.

Respiratory Protection

A NIOSH Approved Supplied-Air Respirator (SAR) or Self-Contained Breathing Apparatus (SCBA) is required to enter a regulated area. EHS assesses each use case and determines the appropriate respiratory protection based on the EPA rule as part of UCLA's Respiratory Protection Program.

Exposure Control Plan

Elimination

Use of DCM is allowed under this Program as a laboratory chemical and in waste operations to dispose of materials generated through use as a laboratory chemical. These uses cannot be eliminated at UCLA because of DCM's unique chemical properties and in order to ensure results from ongoing experiments

can be compared with previously-obtained experimental results. In accordance with EPA regulation, all uses not explicitly permitted under this Program shall be eliminated.

Lab/Shop-Specific ECPs

The template on the following two pages may be used to complete an Exposure Control Plan (ECP) for specific uses of DCM. Each Principal Investigator (PI) and/or Supervisor is responsible for developing, reviewing, and approving ECPs for all procedures that use DCM in locations they are responsible for. One ECP may cover more than one procedure so long as all control measures are consistent across all covered procedures.

This Exposure Control Plan covers safety practices to be followed for use of dichloromethane as [INSERT PROCEDURE NAME] in [INSERT LAB ROOM]. The use of dichloromethane is subject to pre-approval by the Principal Investigator (PI) and/or Supervisor. DO NOT USE DICHLOROMETHANE UNTIL YOU HAVE OBTAINED THE NECESSARY PRE-APPROVAL.

Substitution

The following substitutes have been considered for dichloromethane:

- ☐ 2-Methyltetrahydrofuran
- ☐ Cyclopentylmethyl ether
- ☐ Methyl tert-butyl ether
- ☐ Methyl isobutyl ketone
- ☐ Toluene
- ☐ Ethyl acetate
- ☐ Methanol
- ☐ Ethanol
- ☐ Isopropanol
- ☐ Other _____

They have been deemed inadequate for the following reason(s):

- ☐ Undesirable cross-reactivity
- ☐ Poor match for polarity
- ☐ Poor match for density
- ☐ Boiling point too high
- ☐ Need to maintain reproducibility of established procedure
- ☐ Other _____

Engineering Controls

Dichloromethane will be used with the following engineering controls in place:

- ☐ Local Exhaust Ventilation (select one)
  - ☐ Fume hood
  - ☐ Glove box
  - ☐ Exhausted enclosure
  - ☐ Snorkel
- ☐ Splash shield
- ☐ Other _____

Administrative Controls

All occupants of [INSERT LAB ROOM] shall review this WCPP and ECP prior to entry and sign that they have received the information they contain and agree to abide by the training provided to them.
Dichloromethane is approved for use in [INSERT LAB ROOM] in [INSERT USE LOCATION(S)].
Dichloromethane is approved for storage in [INSERT LAB ROOM] in [INSERT STORAGE LOCATION(S)].

Stop all use of dichloromethane if any malfunction of the local exhaust ventilation device indicated above is suspected and contact EHS.

Any PPE suspected of coming in contact with dichloromethane must be changed immediately.

Personal Protective Equipment (PPE)

Dichloromethane may only be handled while wearing the following PPE:

- ☐ Eye Protection
  - ☐ Safety glasses
  - ☐ Goggles
  - ☐ Face shield
  - ☐ Other _____
- ☐ Skin Protection
  - ☐ Lab coat
  - ☐ Apron
  - ☐ Other _____
- ☐ Hand Protection
  - ☐ Nitrile gloves (Double gloved)
  - ☐ Polyvinyl alcohol gloves
  - ☐ LLDPE gloves
  - ☐ Viton gloves
  - ☐ Silvershield gloves

Training and Information

The EPA rule includes requirements for training and also references the OSHA Methylene Chloride Standard training requirements; both EPA and OSHA reference general training requirements (e.g., nature of training required, frequency, etc.) as well as task-specific training. As such, training will be provided through a combination of online courses and lab-directed training by PIs, instructors, and supervisors who oversee the assignment of tasks in the lab.

Hazards of Dichloromethane

Cumulative exposures to DCM can cause cancer and damage to the liver and kidneys. Acute exposures to high concentrations of DCM vapor in poorly-ventilated spaces has caused central nervous system harm, up to and including unconsciousness and death through respiratory paralysis. Direct exposure to skin and eyes can cause irritation.

Campuswide Training

The Laboratory Safety Fundamentals training course in UCRLearning covers hazard identification using chemical labels and Safety Data Sheets and common aspects of PPE training including glove selection, use, donning, doffing, and what to do in the event of contamination. Lab Safety Fundamentals training is required every three years. Chemical Hygiene Plan training verifies that everyone who works in a research laboratory has read this Chemical Hygiene Plan, including this WCPP. Training on the Chemical Hygiene Plan is required annually.

Lab/Shop-Specific Dichloromethane Training

Each PI, instructor, and/or supervisors who oversees the assignment of tasks requiring the use of DCM in the lab shall implement, and document in their lab-specific Exposure Control Plan(s), hands-on training for lab personnel, covering:

1. Task or activity-specific PPE required and location of PPE.
2. Exposure controls required during tasks with DCM, and training on how to use those controls (e.g., appropriate fume hood sash level).
3. The PI, instructor, or supervisor shall ensure that only individuals trained on DCM safety are allowed to perform DCM tasks.

If tasks are modified or new tasks are initiated, the PI, instructor, or supervisor shall notify the Chemical Hygiene Officer as additional DCM monitoring may be required.

Recordkeeping

Compliance records must be retained for a period of five years. Owners and operators, including each PI, instructor, or supervisor who oversees a location where DCM is used or a person who uses DCM, are required to participate in generation and maintenance of these records, as they are crucial in proving adherence to the restrictions set forth by the EPA. It is acknowledged that many of these records and

documentation are already maintained by UCR and by individual research groups associated with overlapping programs such as Medical Surveillance, Training and Chemical Hygiene program elements:

1. Exposure Control Records: These records will be maintained by their generator as specified below.
    a. Lab-specific Exposure Control Plans will be maintained by each PI, instructor, or supervisor who oversees a location where DCM is used or a person who uses DCM.
    b. Implementation records, including inspections, evaluations and exposure control updates, as well as confirmation that affected persons are properly implementing exposure controls, will be maintained by UCR EH&S.
    c. Documentation of Personal Protective Equipment being used as part of the program will be maintained by each PI, instructor, or supervisor who oversees a location where DCM is used or a person who uses DCM.
    d. Training records for Lab Safety Fundamentals will be maintained by UCR EH&S.
    e. Training records for the the Chemical Hygiene Plan will be maintained by each PI, instructor, or supervisor who oversees a location where DCM is used or a person who uses DCM.
    f. Lab-specific training records will be maintained by each PI, instructor, or supervisor who oversees a location where DCM is used or a person who uses DCM.
    g. Maintenance, shutdown or malfunction documentation for facility exposure controls that cause air concentrations to exceed the ECEL or STEL will be maintained by UCR EH&S. Each PI, instructor, or supervisor who oversees a location where DCM is used or a person who uses DCM is responsible for notifying UCR EH&S immediately when such events are suspected to have occurred.
2. Exposure Monitoring Records: Monitoring records will be maintained by UCR EH&S for employees that may be potentially exposed including:
    a. All measurements made to determine conditions affecting monitoring results, including copies of the notifications to the potentially exposed persons
    b. The identities of all potentially exposed persons whose exposure was not measured and whose exposure is intended to be represented by the monitoring
    c. Description of analytical methods
    d. Information on air monitoring equipment, including calibration dates, limits of detection and malfunctions
    e. Objective data being used to forgo initial exposure monitoring including: the use being evaluated, the source of the data, the measurement methods and results, and any other relevant information.
3. Records related to any eligible exemptions will be maintained by UCR EH&S.