Laboratory Safety Plan

University of California, Merced

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Revision History

Laboratory Safety Plan		
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Version	Date Approved	Author	Revision Notes:
1.0	11/16/2022	Melissa M Russell	New campus laboratory safety plan; replaces the Laboratory Safety Plan, Revised 04/2021.
1.1	11/13/2024	Melissa M Russell	Changed "PI/Supervisors are required to self-inspect…annual basis." to "PIs/Laboratory Supervisors are responsible for self-inspecting their laboratories on a routine basis." (p. 64) Updated links.
1.2	03/21/23	Melissa M Russell	Added expanded guidelines for PHSs (pg 29) Added listed carcinogens pg31 Face on pg "14" need to fix pages numbers
1.3	04/14/26	Melissa M Russell	Checked and updated webpage links.

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LIST OF ACRONYMS

Abbreviation	Definition
ACGIH	American Conference of Governmental Industrial Hygienists
ACS	American Chemical Society
AL	Action Level
ANSI	American National Standards Institute
API	Active Pharmaceutical Ingredients
BEAP	Building Emergency Action Plan
BUA	Biologicals Use Authorization
C	Ceiling (limit)
CAS	Chemical Abstract Services
CCR	California Code of Regulation
CHO	Chemical Hygiene Officer
CHP	Chemical Hygiene Plan
CIC	Carcinogen Identification Committee
CUPA	Certified Unified Program Agency
DART	Developmental and Reproductive Toxicant
DOT	Department of Transportation
DTSC	Department of Toxic Substance Control
EC	European List of Notified Chemical Substances
EH&S	Environmental, Health, & Safety
ENM	Engineered Nanomaterials
EPA, Cal/EPA	California Environmental Protection Agency
FM	Facilities Management
GHS	Global Harmonization System
H-Codes	Hazard Codes
HEPA	High Efficiency Particulate Air [filter]
IACUC	Institutional Animal Care and Use Committee
IARC	International Agency for Registration of Carcinogens
IATA	International Air Transport Association
IBC	Institutional Biosafety Committee
IDLH	Immediately dangerous to life or health
IIPP	Injury Illness Prevention Plan
IUPAC	International Union of Pure and Applied Chemistry
LHAT	Lab Hazard Assessment Tool
LSPS	Lab Safety Plan Supplement
NFPA	National Fire Prevention Association
NIOSH	National Institute of Occupation Safety & Health

NTP	National Toxicology Program
OEL	Occupational Exposure Limit
OSHA, Cal/OSHA	California Occupational Safety & Health Administration
PEL	Permissible Exposure Limits
PHS	Particularly Hazardous Substances
PI	Principal Investigator
PPE	Personal Protective Equipment
PPM	Policy and Procedures Manual
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limits
SAA	Satellite Accumulation Area
SDS	Safety Data Sheet
SOP	Standard Operating Procedures
STEL	Short-Term Exposure Limits
TLV	Threshold Limit Values
TWA	Time-Weighted Average
UCLC	University of California Learning Center
UCOP	University of California Office of the President
UCPD	UC Police Department
UN	United Nations
WASTe	Waste Accumulation Storage Tracking electronically
WHO	World Health Organization

UC MERCED - LABORATORY SAFETY PLAN

A. Introduction

Laboratory safety is an integral part of research and is an essential component of workplace practice. Safety is critical in achieving UC Merced's goals of teaching, research, and public service, as well as preventing workplace injuries and illnesses, property losses or damage, and environmental incidents. It is also essential to comply with all applicable health and safety, and environmental protection laws, regulations, and requirements, including California Code of Regulations (CCR), *Title 8, Section 5191*, also known as the "Laboratory Standard".

Risks associated with laboratory research are greatly reduced or eliminated when proper precautions and practices are observed in the laboratory. UC Merced has developed this Laboratory Safety Plan to better manage hazards and mitigate their associated risks. This plan is indented to be the cornerstone of your safety program and is designed to aid faculty, staff and students in maintaining a safe environment to teach and conduct research.

Every laboratory that uses hazardous materials is required to have a copy of the plan readily available to all laboratory personnel. Each laboratory worker must be familiar with the contents of the plan and the procedures for obtaining additional safety information needed to perform their duties safety.

B. How to Use This Laboratory Safety Plan

1. Department Chairs or Unit Heads

1. Ensure all departmental employees have been trained on an annual basis on UC Merced's Injury and Illness Prevention Program (IIPP).
2. Review the Chemical Hygiene Plan, especially your *responsibilities*.

2. Principal Investigators/Laboratory Supervisors

1. Familiarize yourself with UC Merced's IIPP. Ensure that the IIPP is available to all laboratory personnel.
2. Review the entire Chemical Hygiene Plan (CHP), especially your responsibilities on pages 14-17.
3. Prepare a Laboratory Safety Plan Supplement that details the structure of the safety program for your laboratory.

4. Complete and maintain your laboratory-specific SOPs. Ensure they are readily available and laboratory personnel have been trained. SOPs must be reviewed and updated as described in *Chapter 5*.
5. Make sure all laboratory-specific training and all other required safety training documentation (Compressed Gasses, Laser Safety, etc.) is complete, current, maintained and readily available.
6. Conduct annual inspections (either on paper or online) of your laboratory or other work locations and maintain all associated records, and ensure they are readily available.
7. Conduct laboratory hazard and PPE assessments as described and make sure all related documentation is maintained and readily available. Review any new information with your staff.

3. Personnel

1. Review UC Merced's IIPP. Familiarize yourself with your department contacts, how to report a hazard in your work environment, and how to report injuries.
2. Review the entire Chemical Hygiene Plan:
    a. Specifically, your responsibilities.
    b. *Chapter 4* to refresh your knowledge on how to identify hazardous materials.
    c. *Chapter 5* to understand how to reduce your potential for exposure to hazardous materials (engineering controls, administrative controls and PPE).
3. Review *Chapter 10* with your PI/Laboratory Supervisor to ensure you know what to do to prepare for and respond to an emergency.
4. Review laboratory hazard and PPE assessments with your PI/Laboratory Supervisor, ensure you know how to properly use, maintain, and acquire additional or replacement PPE, and document your PPE training.
5. Review the laboratory-specific SOPs with your PI/Laboratory Supervisor and document your training. **All training, whether formal or on-the-job, must be documented.**
6. Ask for clarification if there are any questions related to your laboratory work before you begin a new task and seek prior approval for applicable work activities.

C. Laboratory Safety Plan Sections

This Laboratory Safety Plan is comprised of the following sections:

1. Injury and Illness Prevention Program
2. Chemical Safety
3. Biosafety
4. Radiation Safety
5. Animal Care and Use
6. Shop
7. Safety Training and Recordkeeping
8. Inspections, Safety Reviews, and Recordkeeping
9. Hazard Assessments

This information is intended to be a resource and to help laboratory personnel manage hazards and mitigate associated risks. As there are a wide variety of chemical products handled and equipment used in laboratories, it should not be assumed that the precautions and requirements stated in this manual are all-inclusive. Faculty, staff, and students are expected to learn about the hazards of chemical products and laboratory equipment before handling or using them. Principal Investigators (PIs) and Laboratory Supervisors must provide laboratory-specific supplemental information to augment the manual (e.g., written standard operating procedures (SOPs), laboratory equipment manuals, safety data sheets, training records, etc.).

Laboratory operations that use lasers, radioactive materials, radiation producing machines, or include biological hazards, or shop activities must follow additional guidelines outlined in the associated hazard-specific UC Merced Safety Manuals and Programs (e.g. Radiation Safety Program, Laser Safety Manual, Biosafety Program, Shop Safety Manual, etc.).

1. Injury and Illness Prevention Plan

Cal/OSHA requires every employer to have an Injury and Illness Prevention Program (*IIPP*) in place *(Title 8, section 3203).* The University of California, Merced, has implemented a campus-level IIPP program to ensure a safe and healthful work environment for all employees. The IIPP is the umbrella under which all employee health and safety programs are implemented and provides a framework for identifying and correcting workplace hazards. It assigns responsibility for safety to specific individuals and outlines procedures to assure compliance with safety procedures. This safety program must address identification, communication, and correction of hazards, as well as accident investigations, training and recordkeeping. A well-integrated IIPP provides the information required to monitor activities and resources to reduce the risk of workplace injury and illness to maintain a safe work environment

2. Chemical Safety

The UC Merced 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 as required in in *CCR, Title 8, Section 5191* "The Lab Standard". The CHP describes the proper use, 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. Personnel within a laboratory, or those whose work activities are research-related and involve the use of hazardous chemicals, are subject to the requirements of the campus CHP.

Laboratories are also required to develop a Laboratory Safety Plan Supplement (*LSPS*) with their lab-specific SOPs and training records to satisfy the campus CHP components necessary for their specific work environment, activities, and hazards. that contains laboratory-specific content, including chemical storage locations, emergency contacts and meeting locations,

3. Biosafety

UC Merced's *Biosafety Program* specifies responsibilities, practices, procedures and operational standards required for the safe use and handling of biohazardous material for research and teaching based on the current state, federal and local agency regulations and guidelines. For research that involves recombinant nucleic acid (unless exempt from NIH Guidelines), microorganisms infectious to humans, animals or plants, or human and non-human primate source materials (tissues, organs, cells, blood or other body fluids); or storage of those biohazardous materials, a *Biological Use Authorization* (BUA) must be submitted. No work with infectious biological agents or rDNA is permitted on the UC Merced campus without prior approval of a BUA. The BUA approval process by the *Institutional Biosafety Committee* (IBC) is based on guidelines from the Centers for Disease Control and Prevention and the National Institutes of Health. Contact EH&S for additional information on the Biosafety Program.

4. Radiation Safety

The Radiological Safety Division of EH&S oversees the safe use of radioactive materials, x-ray producing machines, and high intensity light sources that includes lasers. Three areas of radiological safety covered by this program include:

A. *Radioactive Materials*
B. *X-ray Producing Machines*
C. *High Intensity Light Sources/Lasers*

NO WORK with these materials and equipment can be performed on campus prior to approval of a Radiation Use Authorization (RUA).

5. Animal Care and Use

Use of animals in research and teaching activities at UC Merced is governed by the *Institutional Animal Care and Use Committee* (IACUC). This committee is responsible for reviewing all animal use protocols, ensuring compliance with federal regulations, inspecting animal facilities and laboratories, and overseeing training and educational programs. Federal regulations and accreditation standards require that all proposed uses of animals undergo review by the IACUC. Contact the IACUC office via *iacucoffice@ucmerced.edu.*

6. Shop

EH&S partners with shops to develop and recommend preventive solutions to help everyone work safely. *The Shop Safety Manual* (also located at *https://ehs.ucmerced.edu/facilities*) covers shop safety specifics, such as guarding requirements for machines and proper lifting techniques.

7. Training and Record Keeping

Effective training is a critical component to facilitating a safe environment and for the prevention of laboratory accidents. All employees must be trained in general safe work practices and be given specific instructions on hazards unique to their job assignment and laboratory.

Achieving safety training requirements is a cooperative effort between departments, Principal Investigators and Laboratory Supervisors, laboratory staff and EH&S. It is *strongly recommended* that PIs assign a designated safety person for their lab, and support and empower this person/role. The designated safety person should coordinate initial and refresher training and be a point of contact for inspections.

An effective health and safety training program must include appropriate oversight, proper recordkeeping, instruction on the proper use of PPE (e.g., eye protection, gloves, laboratory coats, respirators, etc.), and extensive outreach. Accurate recordkeeping of training activities demonstrates a commitment to the safety and health of the UC Merced community, integrity of research and protection of the environment.

8. Laboratory Inspection Records

EH&S has established a laboratory inspection program for all UC Merced laboratories. These inspections are performed on a periodic basis by EH&S Safety Specialists to assist PIs/Laboratory Supervisors in maintaining a safe laboratory environment and to aid in compliance with Federal, State, County regulations and University policies. Most of the applicable standards are contained in *CCR, Title 8, Sections 3380-3385* and *5191*, *CCR, Title 19, Div.1, State Fire Marshal* and in *Title 40 of Code of Federal Regulations, Environmental Protection Agency*. The EH&S Safety Specialists conduct inspections, issue reports, assist investigators with regulatory compliance, conduct follow-up reviews to ensure timely corrective actions, and provide training and advice on laboratory safety.

PIs/Laboratory Supervisors are required to inspect their own laboratory on a routine basis, at least annually. A self-inspection checklist that mirrors the inspection checklist is available, either on paper or *online* (through Inspect), for this purpose. Regular inspections performed by internal personnel have been shown to substantially improve safety conditions and will help to ensure fewer findings when inspections are performed by EH&S personnel or regulatory inspectors. All internal inspection reports must be maintained for a period of five years by the PI or Laboratory Supervisor, while records of inspections conducted by EH&S Safety Specialists are maintained by EH&S.

9. Laboratory Hazard Assessment Tool

The *Laboratory Hazard Assessment Tool* (LHAT) helps to categorize laboratories according to risk based on the types of hazards present in the laboratory. The LHAT identifies laboratory activities involving chemical and other types of hazards and specifies the proper PPE that should be used by laboratory personnel to protect themselves against these hazards. Once the appropriate PPE is identified, the laboratory **must** provide the required PPE (*8 CCR §3380* "Personal Protective Equipment") to laboratory personnel and conduct and document training for laboratory staff on the proper use of the PPE. Laboratories are required to provide information to EH&S concerning: the laboratory location; laboratory personnel roster; identify the PI/Laboratory Supervisor; and the Laboratory Safety Coordinator, if applicable; and certify that the assessment and training were completed. The LHAT must be completed at least annually and updated whenever hazards in the laboratory change. It is the responsibility of the PI/Laboratory Supervisor to keep the laboratory location and personnel roster within LHAT

updated at all times. The laboratory or facility's most recent hazard assessments must be readily available and maintained by the PI/Laboratory Supervisor.

Note that the LHAT **does not** identify all the hazards present in a particular work environment. PIs/Laboratory Supervisors must evaluate whether there are additional hazards in their laboratories not addressed by the LHAT.

D. Questions

For further information on this Laboratory Safety Manual or on any health and safety related topics, please contact *EH&S*.

UC MERCED - CHEMICAL HYGIENE PLAN

I. Introduction

A. Purpose

UC Merced is dedicated to providing a healthy and safe working environment for the campus community. This campus Chemical Hygiene Plan establishes a formal written program for managing the risks posed by health and safety hazards associated with the use of hazardous chemicals in laboratories and research. The CHP describes the proper use, handling, storage and disposal practices and procedures to be followed by faculty, staff, students, visiting scholars, volunteers, and all other personnel working with hazardous chemicals at UC Merced. This plan is based on best practices identified in, among others sources, *Prudent Practices for Handling Hazardous Chemicals in Laboratories*, published by the National Research Council, and the American Chemical Society's (*ACS*) *Safety in Academic Chemistry Laboratories*.

B. Scope

This CHP applies to UC Merced personnel (faculty, staff, hosted visitors, students, guests and volunteers, and contractors) within a laboratory where hazardous chemicals are used or stored, or those whose work activities are research-related and involve hazardous materials. It does not apply to research involving exclusively radiological or biological materials, as these safety procedures and regulatory requirements are outlined in the *Radiation Safety Manual* and *Biosafety 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. Additional oversight may be required based on the work being done.

The CHP contains information that represents best practices and provides a broad overview of the information necessary for the safe operation of laboratories that utilize hazardous materials. **It is not intended to be all inclusive**. Additional laboratory specific hazards and mitigation strategies should be listed in the *Laboratory Safety Plan Supplement* (LSPS) and must be filled out by the PI or assigned lab manager**.** Contact *EH&S* for assistance with the development of this document.

C. Regulatory Requirements

The implementation of the necessary work practices, procedures, and policies outlined in this CHP are required by the following California State Regulations:

- *8 CCR §3203*, "Injury and Illness Prevention Program"
- *8 CCR §3380*, "Personal Protective Devices"
- *8 CCR §5143*, "General Requirements of Mechanical Ventilation Systems"

- *8 CCR §5154.1*, "Ventilation Requirements for Laboratory-Type Hood Operations"
- *8 CCR §5164*, "Storage of Hazardous Substances"
- *8 CCR §5191*, "Occupational Exposures to Hazardous Chemicals in Laboratories"
- *8 CCR §5194*, "Hazard Communication"
- *8 CCR Article 110*, "Regulated Carcinogens"
- *29 CFR 1910.1450* Occupational Exposure to Hazardous Chemicals in Laboratories (the "Laboratory Standard")

These regulations require that the CHP be readily available whenever potentially hazardous chemicals are used, handled, or stored. EH&S will review and evaluate the effectiveness of the CHP at least annually and update it as necessary.

D. Rights and Responsibilities

All employees and other personnel who work in laboratories have the right to be informed about the potential 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* (California Occupational Safety and Health Administration) if they feel they are being exposed to unsafe or unhealthy work conditions, and they 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 (209) 228-2EHS or by using the *online Report* on the EH&S website.**

Responsibility for the health and safety of the campus community extends to the highest administrative levels of UC Merced. The Chancellor and Vice Chancellors are responsible for the implementation of UC Merced's Environmental Health and Safety policies at all facilities and properties under campus control. College Deans, Department Chairs, and Unit Heads are responsible for establishing and maintaining programs in their areas and for providing a safe and healthy work environment.

While the Chancellor, Vice Chancellors, Deans and Department Heads are responsible for the broad implementation and enforcement of UC Merced's Environmental Health and Safety Policy, 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 and associated departments.

All personnel have a duty to fulfill their obligations to maintain a safe work environment and minimize the risks associated with their workplace hazards.

All employees and other personnel working with hazardous chemicals have the responsibility to conscientiously participate in training classes on general laboratory safety and read 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 (including available

engineering controls), and proper PPE required for the safe completion of their work activities. Failure to comply with these requirements will result in progressive disciplinary action in accordance with University policy, and may result in temporary suspension of work activities until corrective action is implemented.

1. Responsibilities of the Chancellor and Provost

The ultimate responsibility for the overall campus Environmental Health and Safety Program rests with the Chancellor and Provost at UC Merced. They are responsible for the development and interpretation of campus polices relating to laboratory and chemical safety and this UC Merced Laboratory Safety Plan.

The Chancellor and Provost have delegated their responsibility for laboratory and chemical safety to the Office of Environmental Health and Safety and specific individuals as described below.

2. Responsibilities of School Deans and Vice Chancellors.

Deans and Vice Chancellors are responsible for supporting Departments under their jurisdiction and ensuring compliance with all safety related policies. This support demonstrates a willingness of the School or Administrative Unit to provide the necessary resources to promote a health and safe work environment, as well as aid in the enforcement of UC Merced polices and procedures.

3. Responsibilities of Department Chairs or Unit Heads

Department Chairs or Unit Heads assumes the responsibility for personnel engaged in the laboratory or research use of hazardous chemicals within their Department or Unit. While they have the ability to delegate some of these responsibilities, they must ensure that they are carried out to completion. The Department Chair or Unit Head is responsible for:

1. Establishing and maintaining Department programs that provide safe and healthy work environment

2. Providing resources necessary to mitigate risk from potential hazards, assuring appropriate training, and assisting in enforcement of campus polices and procedures

3. Providing the Chemical Hygiene Officer with the support necessary to implement and maintain the CHP

4. May serve as the Chair of a Department/Unit Safety Committee

5. Ensuring that all chemical inventories for the Department/Unit are entered and maintained in the chemical inventory system (*UC Chemicals*)

6. Reviewing the results of inspections and audits for Department/Unit areas

7. Ensuring corrective actions are completed to address any identified deficiencies and working to maintain compliance with all applicable Department/Unit, university, local, state, and federal codes and regulations

8. Paying fines resulting from citations as a result of action or failure of department to comply with health/safety or environmental laws and regulations

4. Responsibilities of Principal Investigators & Laboratory Supervisors

The PI/Laboratory Supervisor is responsible for the health and safety of all personnel working in their workplace who handle hazardous chemicals. The PI/Laboratory Supervisor may delegate safety duties but remains responsible for ensuring those duties are successfully completed. The PI/Laboratory Supervisor is responsible for:

1. Discussing safety expectations for new employees and students on their first day and/or before they are granted access to the laboratory or other facility
2. Identifying hazardous in the laboratory or other facility and determining safe procedures and controls and implementing and enforcing standard safety procedures. Maintaining current information on laboratory activities, personnel, and laboratory locations within *LHAT.* This includes hazards posed by off-campus or field research activities.
3. Training all laboratory personnel or other personnel they supervise to work safely with hazardous materials. This includes:
    a. Providing and documenting a site specific *safety orientation* for the workplace and training on common processes on the first day an individual is granted access to or assigned work activities within the PI/Lab Supervisor's laboratory.
    b. Ensuring that all personnel successfully complete the *Laboratory Safety Fundamentals* training prior to receiving unescorted access to the laboratory
    c. Conducting laboratory-specific or other specialized training where applicable.
    d. Training records must be maintained; electronic records encouraged
4. Requiring that all laboratory personnel have access to and comply with the CHP, applicable Safety Manual(s), and their LSPS, and ensuring they do not operate equipment or handle hazardous chemicals without proper training
5. Ensuring the availability of all appropriate PPE (e.g., lab coats, gloves, safety eyewear, etc.) and that the PPE is maintained in working order
6. Knowing all applicable health and safety rules and regulations, training and reporting requirements, and standard operating procedures (SOPs) associated with chemical safety for regulated substances
7. Establishing standard safety operating procedures (general and protocol specific) and performing literature searches relevant to health and safety for laboratory-specific work

8. Consulting with EH&S and/or Departmental Safety Committee on use of higher risk materials such as particularly hazardous substances, or high-risk experimental procedures so that additional safety precautions may be taken
9. Monitoring the safety performance of personnel. Actions to correct deficient work practices must be taken if they may lead to illness or injury, these actions shall be documented
10. Requiring visitors follow laboratory rules, and assuming responsibility for laboratory visitors. NOTE PIs/Laboratory Supervisors must follow the *policies* regarding minors in University laboratories or shops where hazardous chemicals, biohazardous or infectious materials, radioactive materials or radiation-producing equipment, or where there are physical hazards including (but not limited to) compressed gases, high voltage, extreme temperatures, excessive noise, or lasers are present.
11. Maintaining and updating the chemical inventory for the laboratory or facility and promptly disposing of unwanted hazardous chemicals and materials following UC Merced, state, and federal waste disposal requirements
12. Complying with all state and federal regulations for shipment of any hazardous materials. Consult with EH&S for further information on the requirements.
13. Requiring the proper operation of appropriate workplace engineering controls (e.g., fume hoods) and safety equipment (e.g., emergency showers/eyewashes, fire extinguishers, etc.), and promptly notifying EH&S and/or Facilities Management should they become non-operational.
14. Conducting periodic *self-inspections* of laboratory or facility, at least annually, and maintaining records of inspections.
15. Promptly reporting accidents and injuries to EH&S. All explosions, unintended fires, or uses of a fire extinguisher must be reported by calling 911. Serious injuries MUST be reported to EH&S (209) 201-9820 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
16. Immediately reporting any fires or fire extinguisher discharge to the Fire Department, even if the fire is extinguished
17. Providing funding for medical surveillance and/or medical consultation and examination for laboratory and other personnel, as required
18. 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
19. Investigating all accidents, incidents, and near-misses to determine the cause and implement corrective action for prevention of future occurrences. Near-misses should be discussed collectively within the laboratory/research group. Contact EH&S for assistance with investigation and development of corrective actions.

20. Informing facilities personnel, other non-laboratory personnel, and any outside contractors of potential workplace-related hazards when they are required to work in the environment. This includes identifying and managing potential hazards to provide a safe environment for repairs and renovations.
21. Paying fines resulting from citations as a result of action or failure to comply with health/safety or environmental laws and regulations.
22. In the event that the PI/Laboratory Supervisor will be on extended leave (i.e., more than 14 days) provisions must be made to designate a responsible person for the workplace. In addition, the PI/Laboratory Supervisor may want to place limitations on the type or scope of work that is performed during the absence and review emergency procedures with all personnel. Exceptions can be made where the PI/Laboratory Supervisor is easily contacted by telephone or e-mail and maintains weekly interactions with the laboratory personnel.

Laboratory Safety Plan Supplement: PIs/Laboratory Supervisors have to create a site-specific Laboratory Safety Plan Supplement to augment the campus *CHP*. The Laboratory Safety Plan Supplement can be customized to the exact workplace hazards present in the laboratory or facility and outline the safety program structure and expectations for the laboratory. Materials in the Laboratory Safety Plan Supplement must receive approval from the PI/Laboratory Supervisor prior to implementation. Contact the Chemical Hygiene officer or *EH&S* for assistance if needed.

5. Responsibilities of All Personnel Who Handle Potentially Hazardous Chemicals

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

1. Reviewing, understanding, and following requirements of the: CHP; all applicable Safety Manual(s), Programs, and Policies; and their Laboratory Safety Plan Supplement
2. Following all required verbal and written workplace safety rules, regulations, and SOPs
3. Developing good personal chemical hygiene habits, including but not limited to, keeping work areas safe and uncluttered, cleaning up following work activities, and practicing good housekeeping in the workplace
4. Planning, reviewing, and understanding the hazards of materials and processes in their laboratory research or other work procedures prior to conducting work
5. Utilizing appropriate measures to control identified hazards, including consistent and proper use of engineering controls, administrative controls, and PPE
6. Understanding the capabilities and limitations of PPE issued to them, and properly maintaining this PPE
7. Being prepared for laboratory accidents and knowing emergency response procedures

8. Gaining prior approval from the PI/Laboratory Supervisor for the use of restricted chemicals and other materials or equipment
9. Consulting with PI/Laboratory Supervisor before using higher risk chemicals (e.g. particularly hazardous substances, explosives and other highly reactive chemicals), or conducting certain higher risk experimental procedures. Notifying other laboratory members of the hazards posed by the chemicals/activities prior to beginning work
10. Immediately reporting all accidents, incidents (including near-misses), injuries, and unsafe laboratory conditions/activities to the PI/Laboratory Supervisor.
11. Immediately reporting any fires or fire extinguisher discharge, even if the fire is extinguished, to the Fire Department and the PI/Laboratory Supervisor.
12. Immediately reporting any new or previously unrecognized workplace hazards within their department to their PI/Laboratory Supervisor or EH&S (via Report an Incident or Concern).
13. Completing all required health, safety, and environmental training and providing documentation to their supervisor
14. Participating in Medical Surveillance, when required
15. Informing the PI/Laboratory Supervisor of any work modifications ordered by a physician as a result of medical surveillance, occupational injury, or exposure
16. Discussing with the PI/Laboratory Supervisor, and receiving prior approval for, any activities and procedures that are to be conducted while alone in the laboratory
17. When performing independent research or work:
    a. Reviewing the written plan or scope of work for their proposed research with the PI/Laboratory Supervisor
    b. Notifying in writing and consulting with the PI/Laboratory Supervisor in advance if they intend to deviate from previously reviewed procedures (Note: changes may include, but are not limited to, change in the objectives, change in PI, change in the duration, quantity, frequency, temperature, or location, increase or change in PPE, and reduction or elimination of engineering controls)
    c. Preparing SOPs and performing literature searches relevant to safety and health appropriate for their work
    d. Providing appropriate oversight, training, and safety information to laboratory or other personnel they supervise or direct

On termination or transfer of laboratory personnel, all their related hazardous materials (including chemicals and samples) shall be properly disposed or transferred to the PI/Laboratory Supervisor or a designee, with the chemical inventory updated appropriately.

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

EH&S is responsible for administering and overseeing institutional implementation of the Laboratory Safety Program. The Chemical Hygiene Officer (CHO) has primary responsibility for ensuring the implementation of all components of the CHP. If situations

are immediately dangerous to life or health (IDLH), EH&S Safety Professionals, including the campus CHO, have the authority to order the cessation of the activity until the hazardous condition is abated and risk sufficiently mitigated. The campus CHO, with support from other EH&S personnel, is specifically responsible for:

1. Informing PIs/Laboratory Supervisors of all health and safety requirements, and assisting with the selection of appropriate safety controls, including engineering controls, laboratory and other workplace standard practices, training, PPE, etc. to minimize the risks posed by laboratory hazards.
2. Assisting the PI/Laboratory Supervisors in the development of their SOPs and Laboratory Safety Plans.
3. Assisting the PI/Laboratory Supervisors in their laboratory hazard assessments, upon request.
4. Providing consultation on the results of laboratory inspections and appropriate actions to abate hazards that may pose a risk to life or safety.
5. Providing technical consultation in the development and implementation of appropriate chemical hygiene policies and practices and development of SOPs
6. 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
7. Providing technical guidance and investigation, as appropriate, for laboratory and other types of accidents, incidents, and injuries
8. Promoting safety training offered by UC Merced where appropriate
9. Assisting Occupational Health Physicians in determining the appropriate medical surveillance requirements for personnel, if any
10. Reviewing and evaluating the effectiveness of the campus CHP at least annually and updating it as appropriate
11. Providing assistance with environmental compliance, transport and disposal of hazardous waste, and the chemical inventory

II. Training

A. Regulatory Requirements

The necessary work practices, procedures, and policies outlined in this chapter are required by the following:

- *8 CCR §3380*, "Personal Protection Devices"
- *8 CCR §5191*, "Occupational Exposures to Hazardous Chemicals in Laboratories"
- *8 CCR §5194*, "Hazard Communication"
- *8 CCR §5209*, "Carcinogens"
- *19 CCR §2659*, "Training"

B. Introduction

Effective training is critical to facilitate a safe and healthy work environment and prevent laboratory accidents. All PIs/Laboratory Supervisors must participate in formal safety training and ensure that all their employees have appropriate safety training before working in a laboratory. Comprehensive resources are available at the *EH&S website for training*.

C. 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

EH&S offers *online training*, plus resource materials to assist laboratories in implementing laboratory-specific training.

1. General Laboratory Safety Training

All laboratory personnel are *required* complete the online *UC Laboratory Safety Fundamentals* training course prior to working in the laboratory and being granted unescorted access. The UC Laboratory Safety Fundamentals training includes:

- Review of laboratory rules and regulations, including the Chemical Hygiene Plan
- Recognition of laboratory hazards
- Use of engineering controls, administrative controls, and PPE 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 required by *8 CCR §3204* regarding access to employee exposure and medical records

Refresher training for "Fundamentals" is required every three years.

2. Laboratory-Specific Safety Orientation & Training

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

- Location and use of the Laboratory Safety Plan, Laboratory Safety Plan Supplement, Chemical Hygiene Plan, IIPP, SDS(s) and other regulatory information
- Review IIPP and Emergency Action Plan, including location of emergency equipment and exit routes.
- Specialized equipment, including Engineering Controls
- Administrative Controls, including Standard Operating Procedures
- Personal Protective Equipment
- Chemical Spill Response
- 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 *On-Site Specific Orientation* checklist to keep record of all orientation training.

Additional EH&S training is required for certain operations. For more information on what trainings to take and the frequency intervals please use *UC Merced's Training Matrix*.

General laboratory safety training requirements are summarized on the EH&S Safety Training Matrix for Laboratory Personnel. A complete list of available health and safety training is provided at the Safety Services Training webpage. This includes classroom as well as online training.

The following provides an outline of the expected general laboratory safety training and frequency intervals:

A. Initial

i. UC Laboratory Safety Fundamentals (includes Hazmat Spill Response and Fire Safety)

ii. Site-Specific Safety Orientation and Training (includes, IIPP, BEAP, CHP, SOPs, Laboratory Safety Plan Supplement, etc.)
iii. Fume hood operation (included in Laboratory Safety Fundamentals) or biosafety cabinet operation (if applicable)
iv. LHAT – PPE Training
v. Lab-specific safety topics (e.g., laser, radiation)
vi. Cryogen Safety (if applicable)

B. Annual

i. IIPP, BEAP, CHP updates, Laboratory Safety Plan
ii. Fire Safety

C. Triennial

i. UC Laboratory Safety Fundamentals refresher

D. Varies

i. Lab-specific safety topics (e.g., laser, radiation)

D. Documentation of Training

Accurate recordkeeping is a critical component of health and safety training. EH&S maintains records of all safety training that it provides. Departments or laboratories are responsible for documenting all other health and safety trainings, including safety meetings, one-on-one training, and any third-party in-class or online trainings. Electronic copies are encouraged, however if hard copies are maintained, documentation should be located in the laboratory's safety binder. For lab-directed trainings please include a sign-in sheet with sufficient details such as date, topics discussed, and who lead the training.

A generic *safety training attendance form* is available on the UC Merced's EH&S website.

III. Chemical Hazard Communication

A. Regulatory Requirements

UC Merced is responsible for providing information about the hazardous substances and activities in our workplace, the associated risks, and the measures to mitigate those risks. UC Merced has an established *Hazard Communication Program* that complies with the Cal/OSHA *Hazard Communication Standard, Title 8 CCR §5194*. 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.

B. List of Hazardous Substances

All laboratories, technical areas, or shops are required to maintain an accurate chemical inventory using the UC Merced online chemical inventory system (*UC Chemicals*). For each hazardous substance on their inventory, specific information on any associated health or safety hazards must be made readily available to all personnel, typically through Safety Data Sheets (*SDS*). Compressed gases must also be included in the inventory list.

C. Hazard Determination

PIs/Laboratory Supervisors are responsible for verifying if any items on their chemical inventory are subject to the requirements of the hazard communication regulation. Note that **"hazardous chemical"** is formally defined in *8 CCR §5191* and *8 CCR §5194*.

The term **"hazardous substance"** refers to any chemical which may present an asphyxiation hazard, environmental hazard, health hazard, physical hazard, or hazard not yet classified. Hazardous substances include, but are not limited to, those chemicals listed in the following:

1. "The Hazardous Substance List", prepared by the Cal/OSHA Director*8 CCR §339*
2. "Toxic and Hazardous Substances, Air Contaminants",*8 CCR §5155*
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), *27 CCR §27001*.

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

1. Safety Data Sheets (SDS)

A SDS must be available for each hazardous substance in a laboratory's chemical inventory. SDSs are 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 workday. SDSs must be in a central location that can be accessed immediately in the event of an emergency.

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 UC-system wide SDS library has the capability of developing new SDSs based on the known chemical and physical properties of that substance. Contact *EH&S* for more information on preparing new SDSs.

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

1. Identification of the substance or mixture and of the supplies

GHS product identifier

- Other means of identification.
- Recommended use of the chemical and restrictions on 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

- Suitable (and unsuitable) extinguishing media.
- Specific hazards arising from the chemical (e.g., nature of any hazardous combustion products).
- Special protective equipment and precautions for firefighters.

6. Accidental release measures

- Personal precautions, protective equipment and emergency procedures.
- Environmental precautions.
- Methods and materials for containment and cleaning up.

7. Handling and storage

- Precautions for safe handling.
- Conditions for safe storage, including any incompatibilities.

8. Exposure controls/personal protection.

- Control parameters, e.g. occupational exposure limit values or biological limit values.
- Appropriate engineering controls.
- Individual protection measures, such a personal protective equipment.

9. Physical and chemical properties

- Appearance (physical state, color, etc.)
- Upper/lower flammability or explosive limits
- Odor
- Vapor pressure
- Odor threshold
- Vapor density
- pH
- Relative density

- Melting point/freezing point
- Solubility(ies)
- Initial boiling point and boiling range
- Flash point
- Evaporation rate
- Flammability (solid, gas)
- Partition coefficient: n-octanol/water
- Auto-ignition temperature
- Decomposition temperature
- Viscosity

10. Stability and reactivity

- Chemical stability
- Possibility of hazardous reactions
- Conditions to avoid (e.g., static discharge, shock or vibration)
- Incompatible materials
- Hazardous decomposition products

11. Toxicological information

- Concise but complete and comprehensible description of the various toxicological (health) effects and the available data used to identify those effects, including:
    - Information on the likely routes of exposure (inhalation, ingestion, skin and eye contact);
    - Symptoms related to the physical, chemical and toxicological characteristics;
    - Delayed and immediate effects and also chronic effects from short- and long-term exposure;
    - Numerical measures of toxicity (such as acute toxicity estimates)

12. Ecological information

- Eco-toxicity (aquatic and terrestrial, where available)
- Persistence and degradability
- Bio-accumulative potential
- Mobility in soil
- Other adverse effects

13. Disposal considerations

- Description of appropriate disposal containers to use.
- Recommendations of appropriate disposal methods to employ.
- Description of the physical and chemical properties that may affect disposal activities.
- Language discouraging sewage disposal.
- Any special precautions for landfills or incineration activities

14. Transport Information

- UN Number
- UN Proper shipping name
- Transport hazard class(es)
- Packing group, if applicable
- Marine pollutant (Yes/No)
- 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

- Safety, health and environmental regulations specific for the product in question.

16. Other information including information on preparation and revision of the SDS

2. Labels 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.

 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)

3. 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. All training must be in the appropriate language, educational level, and vocabulary for laboratory personnel. Employees must be given the opportunity to ask questions. The training requirements and resources for laboratory and research personnel are summarized in Training (*Chapter 2*).

4. 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.

The laboratory's LHAT must be updated whenever hazards in the laboratory or facility change, or new hazards are identified and certified at least annually. The LHAT will **not** identify all the hazards within a laboratory and serves as one tool to aid PIs/Laboratory Supervisors to assess hazards within the workplace.

It should be understood that laboratory hazard assessments involve all potential hazards associated with laboratory work including physical, radiological, laser, biological, as well as chemical hazards**. Non-chemical hazards should not be overlooked.**

IV. Classes of Hazardous Chemicals

A. 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").

B. 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 it 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, using the GHS. 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 at all times.

Rooms containing hazardous chemicals are labeled with a door sign that gives an overview of the key chemical hazards contained within that room. They also provide a list of who to contact in case of an emergency.

Many signs and labels use the GHS pictograms as outlined in *Chapter 3* . Written hazard ratings under the GHS are structured as Hazard Codes (H-Codes) and corresponding Hazard Statements. It's important to note that GHS uses an inverse scale with 0 representing the greatest hazard and subsequent higher numbers represent lower hazard. An example for oral toxicity would be the H-Code of H300 corresponds to "Fatal if swallowed", H301 corresponds to "Toxic if swallowed", and H302 corresponds to "Harmful if swallowed".

An older hazard posting, and labeling methodology is the National Fire Prevention Association (NFPA) four color, 1-4 number rating symbol that quickly supplies the hazard information

broken down into four hazard classes, with 1 indicating the low level of hazard and 4 indicating 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 radioactivity, biohazard, water reactive chemicals, etc. Each of these hazards has a different set of safety precautions associated with them.

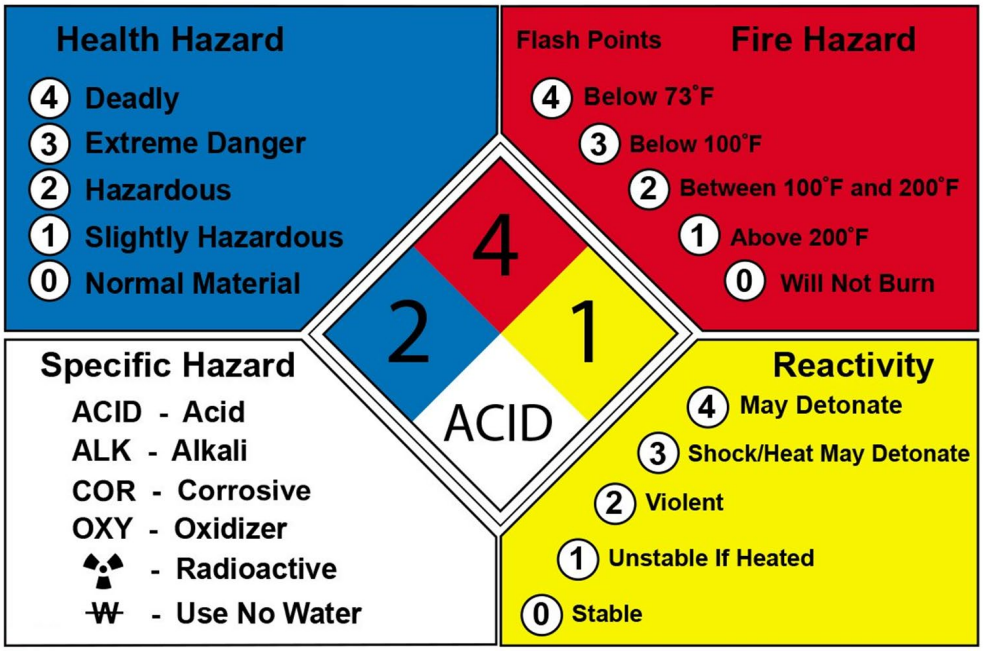


Figure IV-I. NFPA Posting

1. Flammability and Combustibility Hazards

A number of highly flammable substances are in common use in campus laboratories. Flammable liquids include those chemicals that have a flashpoint of less than 100 degrees Fahrenheit. These materials must be stored in flammable storage cabinets when in aggregate quantities of 10 gallons or more. Flame-resistant laboratory coats must be worn when working with large quantities (1 liter or more) of flammable materials and/or with procedures where a significant fire risk is present (e.g., when working with open flame, etc.). These materials can constitute a significant immediate threat and should be treated with particular care, even though the use of these materials is fairly common in the laboratory setting. Particular attention should be given to preventing static electricity and sparks when handling flammable liquids. Bonding and grounding is required when dispensing class 1A liquids from containers 5 gallons or larger.

2. Reactivity and Stability Hazards

Reactive and explosive substances are materials that decompose under conditions of mechanical shock, elevated temperature, or chemical action, and release of 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 laboratory grade refrigerator or freezer that are designed for flammable and reactive chemicals. 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 and flame resistant gloves must always be worn when working with pyrophoric chemicals.

3. Oxidizers

Oxidizers present a fire and explosion hazard when they come into contact with flammable, combustible materials, or other fuels. They can: 1) speed the development of a fire and increase intensity, 2) cause substances which are normally stable in air to rapidly burn, and 3) lead to spontaneous combustion of materials without an obvious ignition source. Oxidizers are classified on a scale of 1-4 by the NFPA based on their potential to initiate spontaneous combustion, with 1 being the lower hazard and 4 being a greater hazard. In addition to the flammability hazards posed by oxidizers, they can also be corrosive or toxic.

4. Health Hazards

Cal/OSHA uses the following definition for health hazards (*8 CCR §5191)*:

"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.

a. 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, and hydrochloric 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, bromine, perchloric acid, and nitric acid.

Symptoms of exposure for inhalation include a burning sensation, coughing, wheezing, laryngitis, shortness of breath, nausea, and vomiting. For eyes, symptoms include pain, blood shot eyes, tearing, and blurring of vision. For skin, symptoms may include reddening, pain, inflammation, bleeding, blistering and burns. As a physical hazard, corrosive substances may corrode materials they come in contact with and may be highly reactive with other substances. 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.

b. Irritants

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

c. 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.

d. Hazardous Substances with Toxic Effects on Specific Organs

Substances included in this category include:

- Hepatotoxins –substances that produce liver damage, such as nitrosamines and carbon tetrachloride.

- Nephrotoxins –agents causing damage to the kidneys, such as certain halogenated hydrocarbons.
- Neurotoxins – 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.

Personnel working with these materials need to review the SDS for the specific chemical being used and take special note of the symptoms of exposure.

e. 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.

i. Establishment of designated areas
   - Often encompasses the entire lab, but can be as small as a fume hood

ii. Use of containment devices (e.g., fume hoods, glove boxes)
   - MUST be used at all times while handling PHSs, to ensure there is no worker exposure

iii. Procedures for contaminated waste disposal
   - See *Hazardous Chemical Waste Management* or contact EH&S for more guidance

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

Particularly hazardous substances are divided into three primary types:

1. 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.

2. 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.

3. 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/m3;
    - 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 have extensive additional requirements associated with them. 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 hour) or short term (15 minutes) threshold values for these chemicals are very extensive.

Listed Carcinogens is a term referring to a list of thirteen specific chemicals contained in *8 CCR §520964* that are considered to pose the highest cancer hazard. They have further requirements for their use in addition to those of regulated carcinogens. Given these strict regulations for Listed Carcinogen use, handling, and/or storage, the Chemical Hygiene Officer (CHO) must be contacted before any work with these agents begins. The Listed Carcinogens are:

- 2-Acetylaminofluorene 4-Nitrobiphenyl
- 4-Aminodiphenyl N-Nitrosodimethylamine
- Benzidine (and its salts) beta-Propiolactone
- 3,3'-Dichlorobenzidine (and its salts) bis-Chloromethyl ether
- 4-Dimethylaminoazobenzene Methyl chloromethyl ether
- alpha-Naphthylamine Ethyleneimine
- beta-Naphthylamine

f. 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 Developmental and Reproductive Toxicant (DART) Identification Committee.

g. Hazardous Drugs, including Active Pharmaceutical Ingredients (API)

Hazardous drugs are a broad class of materials designed to address many different illnesses and disorders in humans and animals. Each hazardous drug has unique properties, and any given hazardous drug may have many different potential health effects associated with it.

Of particular note within this class are antineoplastics, or drugs that act to prevent, inhibit, or stop the development or progression of a neoplasm (tumor). Antineoplastic agents, also referred to as anticancer or chemotherapy drugs, by their nature are harmful to healthy cells and tissues as well as neoplasms. The National Institute for Occupational Safety and Health (NIOSH) has consolidated a *list of antineoplastic and other hazardous drugs*, as well as *developed guidance for handling and preparing such materials*.

A variety of hazardous drugs are used in laboratories across campus and it is vital that these materials be handled with care as they are designed specifically to affect the human body. A control plan that specifies controls to reduce exposure based on individual drug toxicity, hazards, reported Occupational Exposure Limit (OEL), or other safety parameters should be developed.

h. Compressed Gases & Cryogenic Liquids

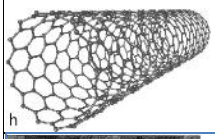
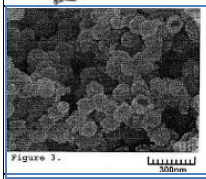
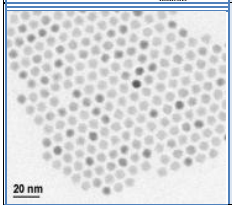
Compressed gases and cryogenic liquids present pressure and asphyxiation hazards in the workplace. Both compressed gases and cryogenic liquids may also present additional health hazard and/or flammability concerns. Given these hazards, special handling and storage requirements must be followed to mitigate the associated risks.

i. 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*)

Type		Examples
	**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, CdSe, 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).

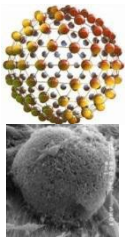
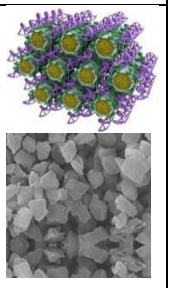
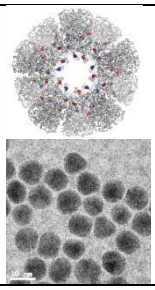
* Carbon Nanotubes are subject to a proposed Recommended Exposure Limit of TWA 7 µg/m^3 due to the risk of developing respiratory health effects.
**Nano-Titanium Dioxide is subject to a proposed Permissible Exposure Limit of TWA 0.3 mg/m^3 due to the risk of developing lung cancer. There are mixed studies regarding TiO_2 skin penetration. Some studies indicate TiO_2 and ZnO does not pass through the stratum corneum, while others indicate significant penetration through the skin.

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*)

Risk Level	Material State or Type of Use	Examples	
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 nanoparticle composites or 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 • **Air:** 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	

V. How To Reduce Exposures to Hazardous Chemicals

A. Regulatory Requirements

The necessary work practices, procedures, and policies outlined in this chapter are required by the following:

- *8 CCR §3380*, "Personal Protective Devices"
- *8 CCR §5141*, "Control of Harmful Exposure to Employees"
- *8 CCR §5154.1*, "Ventilation Requirements for Laboratory-Type Hood Operations"
- *8 CCR §5191*, "Occupational Exposures to Hazardous Chemicals in Laboratories"
- *8 CCR Article 110*, "Regulated Carcinogens"

B. Introduction

Hazardous chemicals require a carefully considered, multi-tiered approach to effectively manage their associated risks. There are four primary routes of exposure for chemicals that have associated health hazards (illustrated in Figure IV-I):

1. Inhalation
2. Absorption (through the skin or eyes)
3. Ingestion
4. 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 via inhalation. Many hazardous chemicals may affect people through more than one of these exposure routes, so it is critical that protective measures are in place for each of these uptake mechanisms.

The methodology for controlling exposures to hazardous chemicals typically proceeds through the following *hierarchy of controls*:

- Elimination
- Substitution
- Engineering Controls
- Administrative Controls
- Personal Protective Equipment

A graphical representation of the hierarchy of controls is illustrated in Figure V-I. Although various illustrations have been used to depict the hierarchy of controls, it is typically represented as an inverted triangle, as developed by *NIOSH*. The rationale behind this hierarchy is that the control methods at the top of graphic are more effective and protective than those at the bottom. Typically, Elimination or Substitution are most easily considered and can be implemented while processes are still under development and design. Existing processes often pose greater challenges for implementing Elimination or Substitution, and thus are typically addressed using the other Safety Controls available.

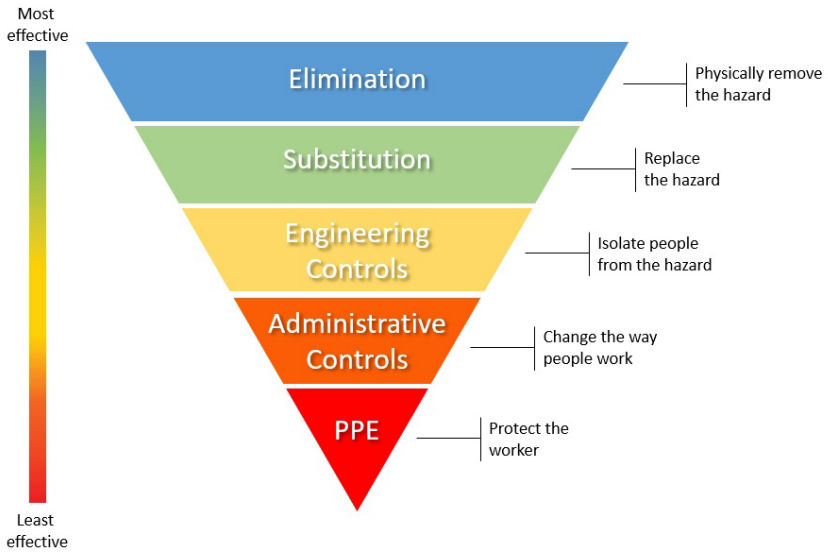


Figure V-I. The Hierarchy of Controls

C. 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.

1. 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

a. 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. See the *UCOP Laboratory Safety Design Guide* for more information.

b. Fume Hoods

Chemical fume hoods are an effective way to control exposure to hazardous chemicals. 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). The exhausts from fume hoods are designed to terminate at least ten feet above the roof deck or two feet above the top of any parapet wall, whichever is higher. Figure V-II displays the key components of a fume hood. It is important to note that the correct type of fume hood to be used is dependent upon the materials involved in the activities.

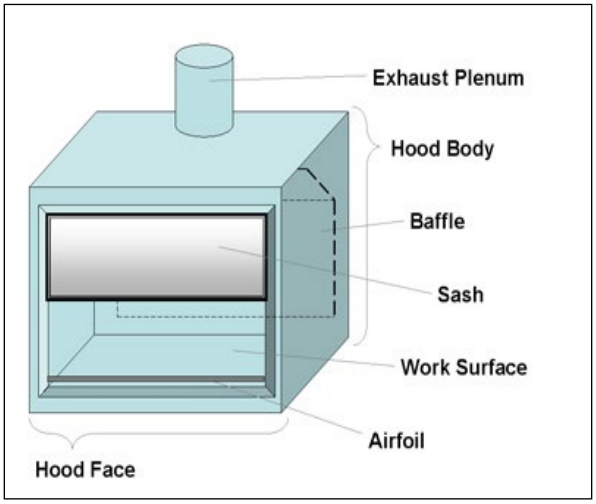


Figure V-I. Fume Hood

Chemical fume hoods should be used for the safe handling of noxious, corrosive, or volatile chemicals whenever possible. In addition, a laboratory hood or other suitable containment device must be used for all work with "particularly hazardous substances". Note, that a fume hood should not be used as a substitute for a biosafety cabinet or a laminar flow hood. Fume hoods are evaluated and certified by a vendor at least once per year. These evaluations verify the proper fume hood air flow velocity to ensure that the unit will operate as designed.

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 your *building manager* 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.

Routine maintenance and repairs of fume hoods are conducted by Facilities Management (FM). Hood users may requests for hood repair directly to FM using the *work order system*. Hood users should remove and properly store excess items and clean the hood surface prior to FM repairing or providing maintenance to the hood. EH&S or the user may initiate maintenance as well as coordinate with FM to ensure that it is completed.

General Rules for Fume Hood Use The following general rules should be followed when using laboratory fume 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. Before beginning work in a fume hood check the fume hood flow indicator to verify proper air flow and make sure the audio alarm has not been disabled.
3. Always keep hazardous chemicals more than six inches behind the plane of the sash.
4. **Never** put your head inside an operating laboratory hood. The plane of the sash is the barrier between contaminated and uncontaminated air.
5. Work with the hood sash in the **designated operating height range.** The maximum operating sash height for vertical sash hoods should be clearly marked. Contact FM if there is no sash height indicated on your fume hood. The sash also acts as a physical barrier in the event of an accident.
6. 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. Clutter inside the hood may disrupt air flow and thus reduce capture efficiency.
7. Do not make any modifications to hoods, duct work, or the exhaust system without first contacting EH&S at **(209) 228-2EHS**.
8. 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.
9. Shut your sash! When 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 regulated carcinogens have additional requirements, such as increased face velocity, contact the EH&S if the intended use changes.

c. Glove Boxes and Ventilated Devices

In addition to chemical fume hoods, some laboratories use contained glove boxes (dry boxes) or other ventilated containment units for working with reactive chemicals under an inert atmosphere, working with very toxic substances in a completely closed system, or for creating a stable, draft-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. 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.

Personnel must be trained in the proper use of this equipment, and the training must be documented.

d. 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 refrigerator or freezer reduced-temperature storage, flammable and explosive materials must be kept in units specifically designed and rated for storing these materials. It is common for laboratories to use a "lab-safe" refrigerator approved for the safe storage of flammable chemicals. 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 visibly 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.

2. Administrative Controls

The next layer of safety controls are Administrative Controls. These consist of policies and procedures to reduce or prevent exposures to laboratory hazards. These controls are generally not as reliable as engineering controls in that the user must carefully follow the appropriate procedures and must be fully trained and aware in order to do so.

EH&S requires that each laboratory have safety procedures, which include safety practices, for any work that involves hazardous materials. Training on these procedures need to be properly documented. Attention must also be paid to the appropriate segregation of incompatible materials.

a. 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. **PI's/Lab Supervisors are responsible for approving all SOPs that their lab relies on.** All personnel responsible for performing the procedures detailed in the SOP shall sign the SOP acknowledging the contents, requirements and responsibilities outlined in the SOP. 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 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 will be 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 product is at least as toxic as the parent compound from which it was derived.

Training on an SOP involves more than simply reading and signing the training documentation form.

For certain hazardous chemicals, PHS, or specialized practices, consideration must be given to whether additional consultation with safety professionals is warranted or required. The SOPs shall be reviewed by qualified personnel and shall be amended and subject to additional review and approval by the Principal Investigator where changes or variations in conditions, methodologies, equipment, or use of the chemical occurs. For certain hazardous chemicals, PHSs, or specialized practices, consideration must be given to whether additional consultation with safety professionals is warranted or required.

3. Personal Protective Apparel and Equipment

a. 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 annual updates thereafter. PPE can be selected based on this hazard assessment. Access the online Lab Hazard Assessment Tool through *https://ehs.ucop.edu/*.

b. How to Use and Maintain PPE

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

c. 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. Persons or companies hired to clean contaminated items should be provided with hazard communication and personal protective equipment.

d. 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, radiological, and biological hazards. However, under certain circumstances respiratory protection may be needed. Examples may include any of the following:

- An accidental spill such as:
    - Chemical spill outside the fume hood.
    - Spill of biohazardous material outside a biosafety cabinet.

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

Because there are numerous types of respirators available, and each has specific limitations and applications, respirator selection and use requires pre-approval by EH&S. For either required or voluntary use of a respirator, the employee must contact EH&S at *ehs@ucmerced.edu* or (209) 228-2EHS, 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 *UCM'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 occur:

- 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

e. Safety Shields

Face shields protect the face, neck, and ears from splash or flying particles. They are worn over safety glasses or chemical splash goggles and should be worn when major splashing may occur.

Standing shields, affixed to the countertop and of good rigidity and strength, protect the face, neck, and upper torso from projectiles when over-pressurization or implosion may occur. These shields must meet the impact test criteria in the ANSI Z87.1 Eye and Face Protection Standard. Standing shields should be considered for the following:

i. Work with potentially explosive compounds.
ii. Systems under high or low pressure.
iii. Scaling up reactions

4. Safe Laboratory Practices

As detailed above, a safety program must include policies and protective equipment to promote a safe working environment, but to truly achieve effectiveness, a number of fundamental elements must become an integral part of our safety culture. According to the American Chemical Society (ACS):

"To build a strong safety culture, all faculty, staff, and students need the skills to recognize hazards, to assess the level of risk of exposure to those hazards, to minimize the risk, and to be prepared to respond to laboratory emergencies."

ACS has prepared a report on *Creating Safety Cultures in Academic Institutions*. It is highly recommended that all researchers review this report. Some of the fundamental or operational elements of an effective safety program and safety culture are detailed below:

a. Wear Personal Protective Equipment

- Wear closed-toe/closed-heel shoes and full-length pants, or equivalent, at all times when in the laboratory (i.e., no exposed skin from waist to toes). **Open shoes, sandals, bare feet, bare shins, bare midriffs, and bare shoulders are prohibited**.
- Use appropriate PPE while in the laboratory and while performing procedures that involve the use, movement, or disposal of hazardous chemicals or materials. Perform hazard assessments to determine the necessary PPE.
- Wear appropriate eye protection in the laboratory.
- Do not manipulate contact lenses while in the laboratory. If they are used, inform the PI/Laboratory Supervisor and the other laboratory personnel that they are being worn.
- Long hair should be tied back or otherwise confined.
- Secure neckties or other articles of clothing or jewelry that might become entangled in equipment.
- Remove laboratory coats or gloves immediately on significant contamination, as well as before leaving the laboratory.
- Do not touch your face, skin, any personal items (phones, glasses, clothing, etc.), or common surfaces (e.g., door handles, elevator button, telephone, compressed gas cylinders, etc.) with gloved hands to prevent contamination.
- Do not reuse disposable gloves, they are a single-use item of PPE.

b. Handle Chemicals Safely:

- Review the SDS to better understand the hazards of any new chemical to be handled and reexamine as needed.
- Properly label and store all chemicals.
- Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures specified in the Chemical Hygiene Plan, WASTe, and SOPs.
- Do not dispose of any hazardous chemicals through the sewer system.
- Do not smell or taste chemicals.
- Never use mouth suction for pipetting or starting a siphon.
- 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. Minor chemical spill information is described in the *CHP* (link to chapter).
    - Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention, as portrayed in the guidance video from *UC Berkeley*.
    - Skin Contact: Promptly flush the affected area with water (15 minutes) and remove any contaminated clothing, after washing seek medical attention.

c. Store and Handle Equipment Properly:

- Use the proper safety equipment for your activities, which may include a chemical fume hood, glove box, biosafety cabinet, shields, or other equipment.

- 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.
- Do not use uncertified fume hoods or glove boxes for hazardous chemical handling.
- Store laboratory glassware with care to avoid damage.
- Inspect all glassware and equipment prior to use; do not use damaged items.
- Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur.
- Handle broken glass and sharps with caution and appropriate hand protection; properly dispose of these materials.
- Keep fume hood sash closed when you are not working in the fume hood.
- Avoid storing materials in fume hoods.
- Do not allow the vents or air flow to be blocked.

d. Know Laboratory Operations:

- Know the location of all exits for the laboratory and the building.
- Know the location and proper operation of safety showers, eyewashes, and first-aid kits.
- Know where the fire extinguishers and alarm pull boxes are located and how they operate.
- Know the location of the nearest phone that can be used in an emergency. Critical phone numbers should be posted near the phone.
- Be prepared for laboratory accidents, chemical spills, and other emergency situations.
- Be prepared for seismic activity
- Know the potential hazards of the materials, facilities, and equipment with which you will work. If you are uncertain, ask your PI/Laboratory Supervisor or contact EH&S.
- Research staff and students should never work alone on procedures involving hazardous chemicals, biological agents, or other physical hazards unless the PI/Laboratory Supervisor has:

    A. Developed an SOP specifically on working alone in the laboratory, and
    B. Granted formal approval for the laboratory activities being performed.

- Follow electrical safety guidance as described in the *Electrical Safety Program*.
- 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.
- Follow written protocols or instructions. Perform only authorized experiments. Do not create shortcuts to procedures.
- When using unfamiliar equipment complete a "dry run" of your experiment using a less hazardous chemical to familiarize yourself with the proper operation of the equipment and PPE.
- If cooling water is required for laboratory activities ensure that the chosen system is not single-pass, utilizing recirculating baths or other water-less alternatives (e.g. *Findenser*^{TM}), consistent with *UCOP Sustainability Policy*.

- Vacuum lines must be protected with traps to prevent vacuum system component contamination. Operations requiring a vacuum must use a trapping device to protect the vacuum source, personnel, and the environment. Do not allow water, solvents, and corrosive gases to be drawn into a building vacuum system. When the potential for such a problem exists, use a cold trap and/or protection (HEPA/hydrophobic) filter.
- 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 (e.g., cooling water). Highly exothermic, potentially explosive reactions, or sudden polymerization reactions must never be left unattended.
- Notify other laboratory personnel when an explosion hazard is present or may be produced, through direct announcement and prominent warning signs.
- Be alert to unsafe conditions and ensure that the PI/Laboratory Supervisor is notified of such conditions, and they are corrected promptly.
- Do not move or disturb equipment in use without consent of the user.
- Do not engage in distracting behavior such as practical jokes in the laboratory. This type of conduct may confuse, startle, or distract another worker.
- Use of headphones in the laboratory, for non-research purposes, is strongly discouraged, some of the risks are highlighted in a *video from Cornell*. If headphones are used in the laboratory for non-research purposes leave one ear unobstructed to be able to hear any sounds and language of any emergency events.
- If personal electronic devices (e.g., laptop, cellular phone, MP3 player, etc.) are used in the laboratory, take precautions to prevent contamination with hazardous materials.
- Wash hands carefully before leaving the laboratory. Beware of contamination on clothing, doorknobs, doorframes, etc.
- Maintain good laboratory cleanliness, including:
    - Clean bench tops, work areas, and equipment regularly.
    - Prevent the accumulation of dirty glassware, unneeded samples/chemicals, and trash.
    - Keep aisles and areas around eyewashes and showers clear to allow for unobstructed exit and easy access to safety equipment in emergency situations.
    - Ensure all compressed gas cylinders are properly restrained.
    - Practice good refrigerator and freezer management by preventing overcrowding, using secondary containment, and completing periodic defrosting procedures.
- Immediately report all accidents, injuries, and near-misses, however small, to the PI/Laboratory Supervisor. Report any fires or the discharge of any fire extinguisher to the Fire Department, even if the fire is extinguished.

e. No Food/Drink:

- No eating, drinking, gum chewing, tobacco chewing, handling contact lenses, and the application of cosmetics (including lip balm) where biological hazards, radioactive materials, or hazardous chemicals will be stored or used. Food must not be kept in refrigerators or cold rooms used for hazardous chemicals or other hazardous materials. Refrigerators used for food and beverage storage shall not be located in the laboratory.

VI. Chemical Exposure Assessment

A. Regulatory Overview

It is University policy to comply with all applicable health, safety, and environmental protection laws, regulations, and requirements. Under *Article 107 of Title 8* Cal/OSHA requires that all employers *"measure an employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance exceed the action level (or in the absence of an action level, the exposure limit)."* Repeated monitoring may be required if initial monitoring identifies 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"* and 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 and Ceiling (C) exposures are not 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.

B. Exposure Assessment Overview

All University employees require protection from exposure to hazardous chemicals above PELs, STELs and Ceiling concentrations. Principal Investigators and supervisors are responsible for assessing hazards. For concerns of airborne chemical exposure, contact EH&S for consultation and further evaluation. Per Cal/OSHA, chemical exposure monitoring must be performed by or under the direction of a person competent in industrial hygiene. At UC Merced, EH&S provides this expertise and serves this role. Contact EH&S at *ehs@ucmerced.edu* or (209) 228-2EHS for general questions regarding exposure assessments.

Minimizing an exposure may be accomplished by elimination, substitution, or using a combination of engineering controls, administrative controls, and PPE, 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, evaluation of chemical properties, visual observation of chemical use, evaluation of engineering controls, use of direct-reading instrumentation, or the collection of analytical samples. An exposure assessment may be performed under situations including the following:

1. Based on chemical inventories, review of SOPs, types of engineering controls present, laboratory inspection results and/or review of hazard assessments, EH&S determines whether an exposure assessment is warranted.
2. 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 and the potential for exposure exists. The user should then inform his or her PI/Laboratory Supervisor, who will in turn contact EH&S to assess exposure potential. 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.
3. Based on a suspected exposure incident following an Employer's First Report.
4. If a Cal/OSHA investigation determines the need for exposure monitoring.

Any serious injury or exposure, including chemical splash involving dermal or eye contact should be immediately reported by **calling 9-1-1** and obtaining emergency medical treatment. Do not wait for an exposure assessment to be performed before seeking medical care.

1. Exposure Assessment Protocol – Notification to employees or employee representatives and right to observe monitoring (*8 CCR §340.1*)

The EH&S Industrial Hygienist 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. In summary, the general protocol in conducting an exposure assessment may include any of the following:

a. Employee interviews.
b. Visual walkthrough and observation of chemical usage and/or laboratory operations.
c. Evaluation of simultaneous exposure to multiple chemicals.
d. Evaluation of potential for absorption through the skin, mucus membranes or eyes.
e. Evaluating existing engineering and administrative controls, as well as PPE.
f. Measuring levels of hazardous substances using various methods.

If exposure monitoring determines an employee exposure to be over the Action Level (or the PEL) for a hazard for which Cal/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, administrative procedures, and/or PPE requirements to maintain exposure below any applicable PEL.

In assessing exposure to hazardous chemicals for which Cal/OSHA has not published a PEL, STEL or Ceiling exposure, EH&S may defer to the Threshold Limit Values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) or the Recommended Exposure Limits (RELs) established by NIOSH. OSHA has consolidated most of this information at *Permissible Exposure Limits – Annotated Tables*.

2. Notification

The Industrial Hygienist will promptly notify the employee and his/her PI/Laboratory Supervisor of the results in writing after the receipt of any monitoring results. The Industrial Hygienist 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 *8 CCR §3204* "Access to Employee Exposure and Medical Records".

3. Exposure Assessment to Determine and Implement Controls

EH&S and Occupational Health Services will use any of the following criteria to determine required control measures to reduce employees' occupational exposure:

a. Verbal information obtained from employees regarding chemical usage.
b. Visual observations of chemical use or laboratory operations.
c. Evaluation of existing engineering control measures, administrative practices, or PPE usage.
d. Recommendations expressed in Safety Data Sheets.
e. Regulatory requirements of Cal/OSHA.
f. Recommendations from professional industrial hygiene organizations.
g. Employee exposure monitoring results.
h. 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 "Control of Harmful Exposure to Employees" (*8 CCR §5141*), the control of harmful exposures shall be prevented by implementation of control measures in the following order:

a. Elimination, whenever possible.
b. Substitution, whenever possible.
c. Engineering controls, whenever feasible.
d. Administrative controls whenever engineering controls are not feasible or do not achieve full compliance and administrative controls are practical.
e. Personal protective equipment, including respiratory protection:

a. During 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

a. 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 possibly associated with a hazardous chemical to which an employee may have been exposed in a laboratory.
2. 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.
3. Upon reasonable request of the employee to discuss medical issues and health concerns regarding work-related exposure to hazardous chemicals.
4. When a measured exposure level requires medical evaluation in accordance with Cal/OSHA regulations.

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 who exhibits signs and symptoms of adverse health effects from work-related exposure to a hazardous chemicals should report to *Occupational Health Clinic* (UC Merced employees) or *Health and Athletic Center* (UC Merced students).

b. Information to Provide to the Clinician

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

1. Personal information such as age, weight, and University employee ID number.
2. Common, trade, and/or International Union of Pure and Applied Chemistry (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 SDS of the hazardous chemical or material in question.
7. History of exposure including previous employment and non-occupational (recreational) hobbies.

8. Any additional information helpful to Health Services in assessing or treating an exposure or injury such as a biological component of exposure or existence of an antitoxin.

It is strongly recommended to bring a copy of the SDS of the hazardous chemical or material in question to any medical evaluation.

c. 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.
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.

d. 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.

e. Medical Surveillance

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

Health Services and/or outside vendors may provide 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
- Bloodborne pathogens
- Formaldehyde
- Lead
- Dichloromethane
- Noise (Hearing Conservation Program)
- Radioactive Materials (Bioassay Program)
- Respirator Use (Respiratory Protection Program)
- Other Particularly Hazardous Substance

Individuals with questions regarding work-related medical surveillance are encouraged to contact *EH&S*.

VII. Inventory, Labeling, Storage, and Transport

A. Regulatory Requirements

The necessary work practices, procedures, and policies outlined in this chapter are required by the following:

- *8 CCR §5154.1*, "Ventilation Requirements for Laboratory-Type Hood Operations"
- *8 CCR §5164*, "Storage of Hazardous Materials"
- *8 CCR §5191*, "Occupational Exposures to Hazardous Chemicals in Laboratories"
- *8 CCR §5194*, "Hazard Communication"
- *8 CCR §5209*, "Carcinogens"

B. Chemical Inventories

Each PI/Laboratory Supervisor is required to maintain a current comprehensive chemical inventory, through the chemical inventory system (*UC Chemicals*), which lists the hazardous chemicals and compressed gases used and stored in the labs and the quantity of these chemicals. This information is managed and reported to meet obligations under the Emergency Planning and Community Right-to-Know Act (EPCRA) that is managed in California by the Certified Unified Program Agencies (*CUPA*). This inventory needs to be updated:

1. At least annually
2. Whenever new chemicals are introduced into the laboratory
3. Whenever a chemical is completely removed from the laboratory

Specific storage locations must be kept as part of the inventory list to ensure that chemicals are easily located. The chemical inventory is used to aid compliance with storage limits, reporting requirements, fire and life safety regulations, and may be used in emergency situations to identify potential hazards to emergency response personnel. Additionally, an accurate chemical inventory aids the operational and financial management of laboratory activities. Active chemical inventory management can also deter chemical diversion, and quickly identify instances where diversion may have occurred. Given the multitude of advantages afforded by an accurate and current chemical inventory, efforts should be taken to actively manage the laboratory's chemical inventory through UC Chemicals.

Management of the laboratory chemical inventory should include the following aspects:

1. Chemical inventory reviewed prior to chemical procurement.
2. Chemical purchases target the minimum quantities necessary for the research, and never exceed quantities that can be consumed within one year.

3. When new chemicals are added to the laboratory, each laboratory group must confirm they have access to the SDS for that chemical and update their UC Chemicals information to reflect the addition of the chemicals to the laboratory.
4. Each chemical container is dated upon receipt so expired chemicals can be easily identified for disposal.
5. Unneeded chemicals should be culled from the inventory and properly disposed to reduce laboratory risk from storage of hazardous materials.
6. Chemicals beyond their expiration dates should be removed via proper disposal.
7. Any visible evidence of chemical or container degradation including:
    - Cloudiness in liquids
    - Color change
    - Evidence of liquids in solids, or solids in liquids
    - "Pooling" of material around outside of containers
    - Pressure build-up within containers
    - Obvious deterioration of containers (e.g., corrosion)

   These indicators should prompt chemical disposal.
8. Chemical quantities are updated frequently, especially after large changes.
9. Chemicals are returned to their designated storage area when not in use.
10. Chemical storage locations are inspected regularly.

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 may be required in the case of acutely toxic or hazardous chemicals, tax-free alcohol (see *PPM 675.03*), select toxins, and controlled substances. Acutely toxic chemicals may include those associated with very low IDLH conditions. For guidance on locked storage requirements, please contact EH&S at (209) 228-2EHS or *ehs@ucmerced.edu*.

Lastly, on termination or transfer of laboratory personnel, all their related hazardous materials (including chemicals and samples) shall be properly disposed of, or transferred to, the PI/Laboratory Supervisor or a designee, with the chemical inventory updated appropriately.

C. 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.

New 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 receipt and the date when the bottle is first opened. For the containers 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.

D. Chemical Storage and Segregation

Establish and follow safe chemical storage & segregation procedures for your laboratory.

Storage and segregation *guidelines* are included for materials that are flammable, oxidizers, corrosive, and water reactive, explosive and highly toxic. 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.

1. 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 must 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. **Specialty Hazard**. Be sure to consider chemicals requiring special handling and storage (e.g., air/water reactive, peroxide forming chemicals, reduced temperature storage, inert atmosphere storage, etc.).
5. **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.

2. General Recommendations for Safe Storage of Chemicals

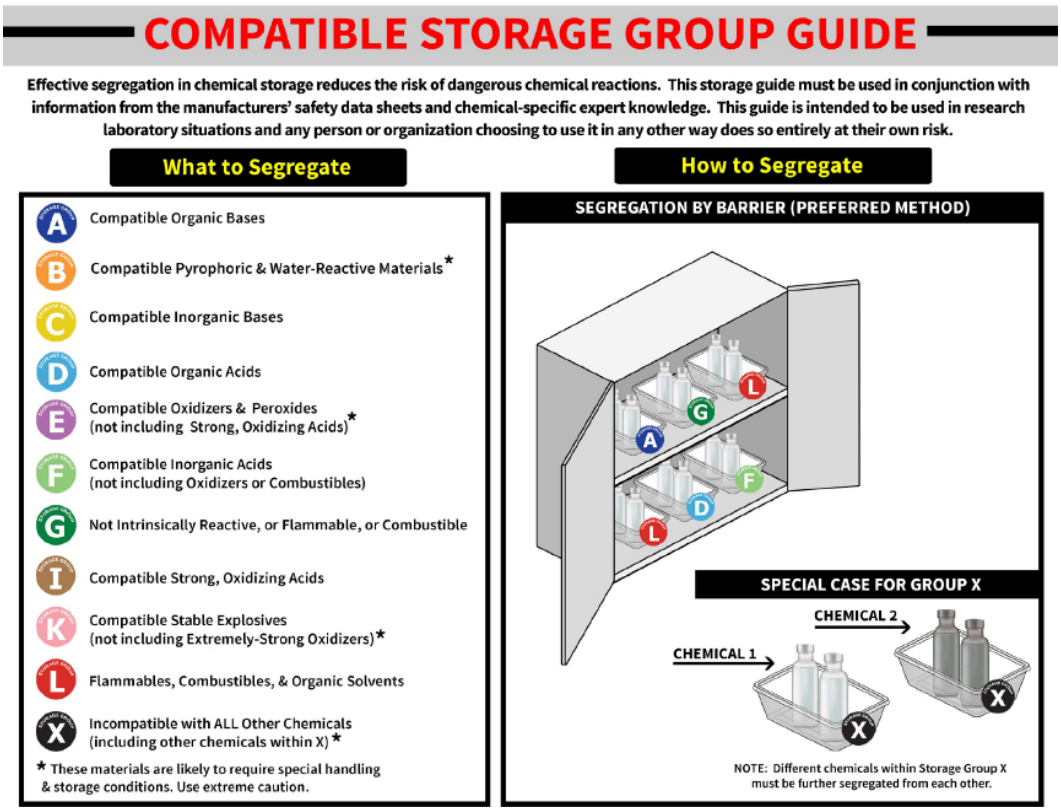
Each chemical in the laboratory should be stored in a specific location and returned there after each use. Acceptable chemical storage locations may include corrosive cabinets, flammable cabinets, laboratory shelves, or appropriate refrigerators or freezers. Fume hoods should not be used as general storage 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. Hazardous liquids, 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 storage of flammable liquids.

3. 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 volume 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 UCM. 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 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	< 73°F (23°C)	< 100°F (38°C)	diethyl ether, pentane, ligroin, petroleum ether
I-B	< 73°F (23°C)	≥ 100°F (38°C)	acetone, benzene, cyclohexane, ethanol
I-C	73 - 100°F (23°C - 38°C)	-----	p-xylene
Hazard Classification for Combustible Liquids			
II	101 - 140°F (39°C-60°C)	-----	diesel fuel, motor oil, kerosine, cleaning solvents
III-A	141°F - 199°F (61 - 93°C)	-----	paints (oil base), linseed oil, mineral oil
III-B	≥ 200°F (93°C)	-----	paints (oil based), neatsfoot oil

4. Pyrophoric & Water Reactive Substances

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.

5. Oxidizers

Oxidizers (e.g., hydrogen peroxide, halogens, potassium permanganate, ferric chloride, potassium dichromate, sodium nitrate, etc.) should be stored in a cool, dry place and kept away from flammable and combustible materials, such as wood, paper, Styrofoam, plastics, flammable organic chemicals, and away from reducing agents (e.g., zinc, alkaline metals, metal hydrides, formic acid).

6. Peroxide Forming Chemicals

Peroxide forming chemicals (e.g., acetaldehyde diethyl acetal (acetal); cumene (isopropyl benzene); cyclohexene ; cyclopentene; decalin (decahydronaphthalene); diacetylene (butadiene); diethyl ether (ether); diethylene glycol dimethyl ether (diglyme); diisopropyl ether (isopropyl ether); dioxane; divinylacetylene (DVA); ethylene glycol dimethyl ether (glyme); ethylene glycol ether acetates; ethylene glycol monoethers (cellosolves); furan; inylidene chloride (1, 1-di-chloroethylene); methylacetylene; methylcyclopentane; potassium amide; potassium metal ; sodium amide (sodamide); tetrahydrofuran (THF); tetralin (tetrahydronapthalene); vinyl ethers) 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).

The containers **must** be labeled with the date received; it is also recommended to mark the date when the container was 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. Keep an inventory of peroxide-forming chemicals for your workplace, and never purchase more quantity than can be consumed prior to the manufacturer's expiration date 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 stabilizer added 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.

Do not handle the container if:

- Old containers of peroxide-forming chemicals are discovered in the laboratory, (greater than five years past the expiration date or if the date of the container is unknown),
- Crystallization is present in or on the exterior of a container, or
- Visible discoloration, multiple layers, or liquid stratification.

Secure it and contact **EH&S at (209) 228-2EHS** or *email* for inspection, pick-up, and disposal.

7. Corrosives

Store corrosive chemicals (e.g., acids, bases) below a height of five feet and in secondary containment that is large enough to contain at least 10% of the total volume of liquid stored or the volume of the largest container, whichever is greater.

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, potassium ferricyanide).

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 materials.

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.

8. Acutely Toxic Chemicals

Acutely toxic chemicals should be stored based on their hazards and physical properties. Storage for acutely toxic solids and liquids includes secondary containment in a well-ventilated area. Containers should be closed with tape or other sealant. Storage areas for acutely toxic chemicals and their containers must be meticulously labeled. Acutely toxic chemicals shall be stored no higher than eye level (~5ft).

9. Special Storage Requirements

a. Compressed Gas Cylinders

Compressed gas cylinders must be secured to prevent tipping, falling, or rolling caused by contact, vibration, seismic activity, or transportation. Methods for properly storing and securing cylinders include:

- Compressed gas cylinders must be stored with the safety cap in place.
- Gas cylinders shall be segregated by hazard class.
- Secure cylinders upright to a substantial, fixed surface with restraints made of non-combustible material such as chains. **Cylinders are not to be stored in a horizontal position**.

- Do not expose cylinders to excessive dampness or temperatures >125 °F, nor corrosive chemicals or fumes.
- Secure cylinders to (or within) a rack, rail framework, or similar assembly designed for such use.
- Nesting of cylinders is allowed if a minimum of 3-points of contact can be achieved.
- Secure cylinders on carts or other mobile devices designed for the moving of cylinders, when transporting cylinders.

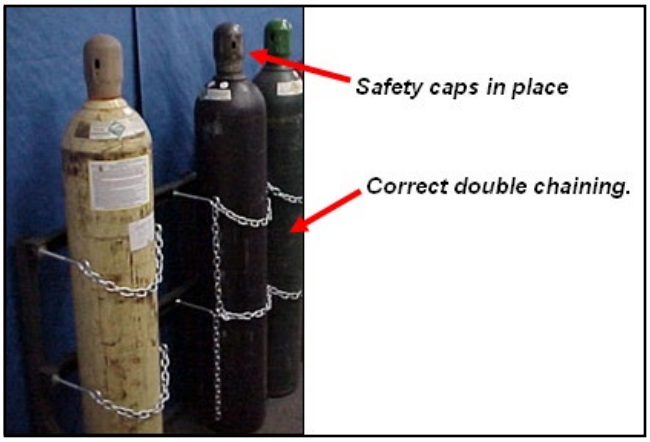


Figure VII-I. Proper Compressed Gas Cylinder Storage

- Cylinders **must** be restrained by at least one non-combustible restraint, but preferably two non-combustible restraints; one restraint at 1/3 from the top of the cylinder, and the other at 1/3 from the bottom of the cylinder (see **Figure VII-I**).
- Bolted "clam shells" may be used in instances where gas cylinders must be stored or used away from walls or racks.

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 oxygen gas cylinders 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.

b. Cryogenic Liquids

Because cryogenic liquid (e.g., nitrogen, argon, helium, etc.) containers are at low pressure and have protective rings mounted around the regulator, they are not required to be affixed to a permanent fixture such as a wall. However, additional protection considerations should be addressed when storing cryogenic liquids in a laboratory. The primary risk to laboratory personnel from cryogenic liquids is skin or eye damage caused by contact with the material. Additionally, all cryogenic liquids have large expansion volumes, typically greater than 500:1 when transitioning from a cryogenic liquid to a room temperature gas. This volumetric increase can create high pressure hazards if confined to a closed system; pressure relief valves must always be functional and unobstructed. While the gases are usually not toxic, a significant risk of

asphyxiation is a possibility due to oxygen displacement. Consult with EH&S prior to locating cryogenic liquids in confined spaces or areas without adequate ventilation. Always use appropriate thermally insulated gloves when handling cryogenic liquids. Face shields may be needed in cases where splashing can occur.

c. 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*). Aspect that should be covered in a SVA include:

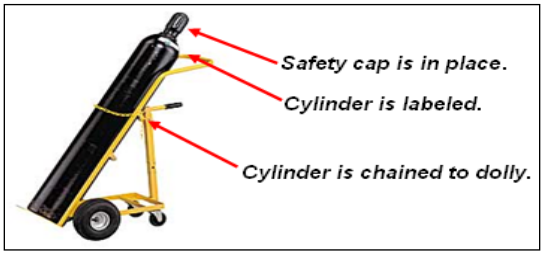
- Existing threats, based on the history of the institution (e.g., theft of laboratory materials, sabotage, data security breaches, protests)
- The attractiveness of the institution as a target, and the potential impact of an incident
- Chemicals, biological agents, radioactive materials, or other laboratory 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 (209) 228-2677 and UCM EH&S at (209) 228-2EHS.

E. On Campus Transport 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 below illustrates correct cylinder transport.



F. 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 limits, packaging, labeling, documentation, and hazard communication. **Without proper training, it is illegal to ship hazardous materials.** Those who violate the hazardous materials shipment regulations are subject to criminal investigation and penalties. EH&S has trained personnel to ship hazardous and biological materials and personnel to ship radioactive materials. Individuals who wish to ship or transport hazardous chemicals, compressed gases, radioactive materials, or biological materials off-campus, must contact EH&S at (209) 228-2EHS. For more information please visit the *Shipping Hazardous Materials* webpage.

VIII. Lab Inspections and Compliance

A. Regulatory Requirements

The necessary work practices, procedures, and policies outlined in this chapter are required by the following:

- *8 CCR §3203*, "Injury Illness Prevention Program"
- *8 CCR §5191*, "Occupational Exposures to Hazardous Chemicals in Laboratories"

B. Laboratory Safety Inspections – Lab Personnel

The primary goal of safety inspections is to identify both existing and potential incident-causing hazards, activities, procedures, and faulty operations that can be corrected **before** an incident occurs. Regular laboratory inspections performed by laboratory personnel have been shown to substantially improve laboratory safety conditions, reduce accidents and incidents, and should help to ensure fewer findings when inspections are performed by regulatory personnel or other campus inspectors.

PIs/Laboratory Supervisors are responsible for self-inspecting their laboratories on a routine basis. While inspections are a snapshot in time and cannot identify every accident-causing condition, they do provide important information on the overall operation of a particular laboratory. Laboratory personnel may use the self-inspection checklist that mirrors the Laboratory Safety Review Program checklist, available either on paper or online through *Inspect*, or use an alternate inspection checklist at the discretion and preference of laboratory personnel that best meets the needs of the laboratory. Follow-up and documentation related to any identified corrective actions is very important. Inspection documentation for recent inspections and follow-up actions should be maintained and readily available.

C. Laboratory Safety Inspections – EH&S

EH&S has a comprehensive laboratory safety inspection 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 UC Merced'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. These inspections are meant to supplement laboratory self-inspections. 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.

The laboratory safety inspection 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:

- Animal Research;
- Biologicals;
- Controlled Substances;
- Fire;
- Laser;
- Training;
- Documentation;
- First Aid Kit;
- Occupational Health;
- Safety Equipment;
- Carcinogens;
- Electrical
- Fume Hood;
- PPE;
- Seismic
- Chemicals
- Chemical Waste
- Equipment
- Gas
- Radioactive Materials
- Shop
- General Safety
- Regulated Medical Waste

Once the inspection is completed, an inspection report is issued via *Inspect*. The report will identify deficiencies in the laboratory, both serious and non-serious. All findings must be corrected within their designated due dates.

If corrective action is not undertaken past 30 days, an escalation process will be initiated in accordance to the *Interim Procedure on Assurance of Laboratory Safety Compliance*.

D. Recordkeeping Requirements

Accurate recordkeeping demonstrates a commitment to the health and safety of the UC Merced community, integrity of research, and protection of the environment. EH&S is responsible for maintaining records of the laboratory inspections conducted by EH&S, accident investigations, monitoring equipment calibration, and training conducted by EH&S staff. Per OSHA regulations, departments or laboratories **must** document health and safety training, including safety meetings, one-on-one training, classroom training, and online training. A copy of recent the most EH&S inspection report and self-inspection documentation **must** also be maintained or otherwise be readily available. Additionally, the following records must be retained in accordance with the requirements of state and federal regulations:

1. Accident records – 5 years
2. Laboratory evaluation reports – 5 years
3. Measurements taken to monitor employee exposures – 30 years
4. Inventory and usage records for high-risk substances should be kept
5. Any medical consultation and examinations records, including tests or written opinions required by *8 CCR §5191*.
6. Medical records must be retained in accordance with the requirements of state and federal regulations – duration of employment plus 30 years

IX. Hazardous Chemical Waste Management

A. Regulation of Hazardous Waste

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 (*RCRA*). Local enforcement authority is administered by the local CUPA, within the Merced County Division of Environmental Health.

B. Hazardous Waste Program

The EH&S Hazardous Waste Program manages the shipment and disposal of all hazardous waste generated on campus. All laboratory personnel must comply with the campus Integrated Hazardous Waste program requirements and all applicable regulations. A regular pick-up service is provided to all research buildings equipped with labs. Laboratory personnel are responsible for identifying, labeling, and properly storing hazardous waste in the laboratory. Laboratory clean-outs and disposal of high hazard compounds must be scheduled in advance. The PI/Laboratory Supervisor is responsible for coordinating the disposal of all chemicals from his/her laboratories including prior to closing laboratory operations.

1. 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 that 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
    - Has an acute oral LD50 less than 2,500 mg/kg
    - Has an acute dermal LD50 less than 4,300 mg/kg
    - Has an acute inhalation LC50 less than 10,000 ppm as a gas or vapor
    - Has an acute aquatic 96-hour LC50 less than 500 mg/l
    - 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").

2. 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., cyanides, sodium azide, and hydrofluoric acid). The Federal EPA refers to this waste as "acutely hazardous waste," but Cal/EPA has published a more detailed list of extremely hazardous waste. Both the State and Federal lists are included in the *UC Davis's EH&S List of Extremely Hazardous Waste*. **NOTE** While there is some overlap with the list of Particularly Hazardous Substances, such as the examples listed above, the extremely hazardous waste list is specific to the hazardous waste management program.

3. Biohazardous and Medical Waste

Please consult the *Medical Waste Management website* for more information.

4. Radiological Waste

Activities that produce or use radioactive materials may generate radioactive waste. Guidance regarding radioactive waste management is described in the *Radiation Safety* webpage on the EH&S's website.

C. Proper Hazardous Waste Management

1. Training

All personnel who are responsible for handling, managing or disposing hazardous waste must attend training **prior** to working with these materials. The EH&S online Hazardous Waste Management training course covers the hazardous waste program requirements and includes training on container labeling. To complete the Hazardous Waste Management training, log on to the *UC Merced's Learning Center*.

2. Waste Identification

All the chemical constituents in each hazardous waste stream must be accurately identified by laboratory personnel, even those components present at trace levels. This is a critical safety issue for both laboratory personnel and hazardous waste technicians who handle the waste once it is turned over to EH&S. 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 personnel must consult the PI/Laboratory Supervisor, the CHO, or the Hazardous Waste Facility Manager. In most cases, careful documentation and review of all chemical products used in the experimental protocol will result in accurate waste stream characterization.

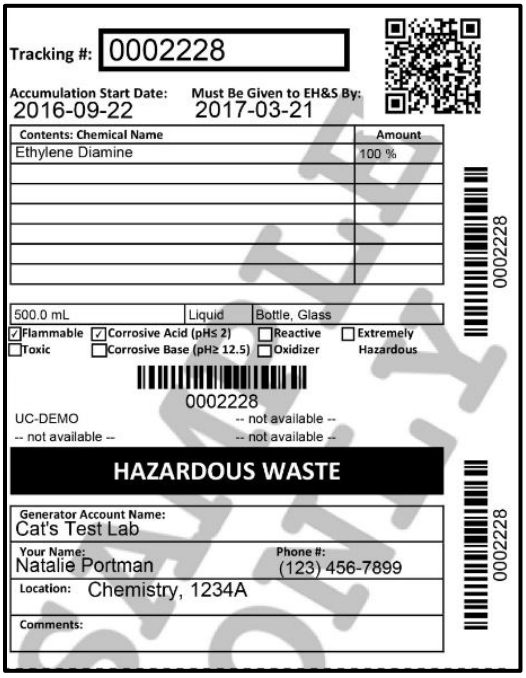


Figure IX-I. Sample label generated from WASTe.

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 Facility Manager.

3. Labeling

Hazardous waste labels must be placed on the hazardous waste container upon the start of accumulation. UC Merced 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. An example of a completed WASTe tag is shown in **Figure IX-I**. Information on how to use WASTe can be found in the next section.

WASTe

4. Waste Accumulation Storage Tracking electronically (WASTe)

a. 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 in which one is assigned. Employees should ascertain if an account has already been established for their PI and associated laboratory(s).

b. 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 complete name of all constituents are 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 (90 days), all the contacts for 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 inventory.

5. Storage

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

1. Hazardous waste containers must be labeled with a WASTe tag at all times.
2. Waste must be collected and stored at or near the point of generation.
3. 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, you must have the waste removed within **3 days** of reaching these set volumes
4. The maximum amount of flammable solvents allowed to be stored in a laboratory is 60 gallons; this limit also includes waste solvents.
5. Hazardous waste streams must have compatible constituents and must be compatible with the containers in which they are stored.
6. All hazardous waste containers in the laboratory must be kept closed when not in use.
7. Hazardous waste containers must be stored in secondary containment at all times.
8. Waste containers must be in good condition with leak proof lids.
9. Waste containers must be less than 90% full.
10. Dry wastes must be double-bagged in clear, three-mil plastic bags.

Do not dispose of chemicals by pouring them down the drain or placing them in the trash

6. Segregation

All hazardous waste must be managed in a manner that prevents spills and unexpected reactions. Additionally, proper waste segregation can help reduce disposal costs. Whenever possible, recommended segregation approaches include:

- Segregate:
  - acids from bases
  - oxidizers from organics
  - cyanides from acids
  - halogenated solvents from non-halogenated solvents
  - radioactive waste from chemical waste
- Exclude metals from solvent wastes.

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

7. 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 catastrophic container failure, resulting in serious injury and property damage. All chemical constituents and their waste byproducts must be compatible for each waste container generated. Waste labels must be immediately updated when a new constituent is added to a waste container, so personnel in the laboratory will be aware and manage the container and waste 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 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.

8. Waste Which Requires Special Handling

a. Sharps

Syringes, glass pipettes, and other sharps contaminated with hazardous materials (chemicals, radioactive, or biological) must be placed in a specially designed rigid container. Do **NOT** use red medical waste containers for non-medical waste sharps; unless the biohazard symbol has been defaced.

EH&S will pick up contaminated sharps waste containers once it has been tagged for disposal. Autoclaved sharps containers of medical waste must be disposed through EH&S or an approved medical waste disposal company; contact EH&S Biosafety for more information.

b. Unknowns

When unknown waste is discovered, an attempt must be made by the group to identify its contents. In the event that the waste cannot be identified, the Institute's hazardous waste contractor will perform an analysis to identify the unknown waste. The cost of the analysis will be charged back to the appropriate party.

What to do when an unlabeled chemical is discovered:

- Make an attempt to identify the contents of the container. Never guess or assume as to the contents of the container.
- If the contents cannot be identified, attach a hazardous waste tag to the container and indicate on the label that the material is unknown.
- Notify EHS of the unknown chemical. EHS will arrange for an analysis of the unknown material.
- There may be a charge for the analysis.

Do **not mix** unknowns if you have multiple unknown hazardous wastes.

For additional information, please contact EH&S at *ehs@ucmerced.edu* or call at (209) 228-2EHS.

c. Peroxide-Forming Chemicals

Peroxide-forming chemicals include a number of substances which 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 thereby concentrating any peroxides that may have formed in the container.

Each container of peroxide forming chemicals must be dated with the **date received**; it is highly recommended to also include 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 peroxide forming chemicals.

Ensure containers of peroxide-forming chemicals are kept tightly sealed to avoid unnecessary evaporation, as this inhibits the stabilizers that are sometimes added. Visually inspect containers periodically to ensure they are free of exterior contamination or crystallization. Peroxide-forming chemicals must be disposed prior to expiration date.

If old containers of peroxide forming chemicals are discovered in the laboratory, (greater than five years past the expiration date or if the date of the container is unknown), **do not handle the container**. If crystallization, visible discoloration, multiple layers, or liquid stratification is present in or on the exterior of a container, **do not handle the container** and contact **EH&S at (209) 228-2EHS immediately.** Secure the immediate area and restrict access to the container until it can be evaluated by EH&S personnel.

d. 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 six 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 the **EH&S at (209) 228-2EHS immediately.** Secure the immediate area and restrict access to the container until it can be evaluated by EH&S personnel.

e. Explosive Compounds with Shipping Restrictions

A variety of other compounds 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 these compounds, employees must ensure they are stored appropriately for transport. Flammable metals must be completely submerged in oil before they are offered for 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 for disposal considerations of these compounds.

f. Chemotherapy Waste

Containers or items which still contain scrapable or pourable amounts of chemotherapeutic material are considered bulk chemotherapy waste and must be disposed of according to the *Medical Waste Management Plan.* Pourable chemotherapy/oncology chemicals should be left in their original containers and offered for hazardous waste pick-up through the EH&S *WASTe* program.

Any waste that is contaminated through contact with, or having previously contained, chemotherapeutic agents, including, but not limited to, gloves, disposable gowns, pipette tips, paper towels, or syringes, may be considered trace chemotherapy waste and must be sent for incineration by a contracted vendor in accordance with the UC Merced Medical Waste Management Plan. Trace chemotherapy needles should be collected in a dedicated chemotherapeutics sharps container, either labeled as such by the manufacturer or a sharps container with the words "Chemotherapy Waste" or "CHEMO". Full sharps containers can be placed directly inside the trace chemotherapy waste barrel if they have a sealed gasket around the lid, otherwise they must be placed in a compliant biohazard bag before being placed in the chemotherapy waste barrel.

g. Animals

Animal carcasses not contaminated with chemicals or radioactive materials are disposed through a contracted service provider. For animal carcasses which have chemical or radioactive material contamination, contact *EH&S* for guidance on the needed disposal method.

9. Accumulation Time

Frequent disposal will ensure that hazardous waste accumulation areas in labs are managed properly, and that accumulation limits are not exceeded. UC Merced policy states that hazardous chemical waste can be stored in a laboratory for up to 90 days. Once a waste container is 90% full or it is near the 90-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.

10. 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.

D. Hazardous Waste Minimization

Even though UC Merced is a small quantity generator of hazardous waste, there are practices that can be done in order to keep waste at a minimum.

1. Administrative Controls

In order to reduce the amount of chemicals that become waste, administrative and operational waste minimization controls can be implemented. Usage of chemicals in the laboratory areas

should be reviewed to identify practices which can be modified to reduce the amount of hazardous waste generated.

Purchasing: When ordering chemicals, be aware of any properties precluding 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 and associated risk. Consider establishing a centralized purchasing program to monitor chemical purchases and avoid duplicate orders. Purchase the minimum quantity needed, and no more than can be consumed within a year.

Inventory: Rotate chemical stock to keep chemicals from becoming outdated, and implement the "first in, first out" approach to stock chemicals. Locate surplus/unused chemicals and attempt to redistribute these to other users, investigate returning unused chemicals to the vendor, or dispose of surplus/unwanted material as hazardous waste through EH&S.

Operational Controls: Review your experimental protocol to ensure 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. Reuse solvents if possible. Spent solvents can also be used for initial cleaning, using fresh solvent only for final rinse. Use less hazardous or non-hazardous substitutes when feasible. Some examples include:

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

2. Drain Disposal

UC Merced 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.

3. 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.

E. Transportation and Disposal

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.

Frequent disposal will ensure that waste accumulation areas in labs are managed properly, and that maximum storage volumes are not exceeded. Once a waste container is 90% full or it is near the accumulation time limit, it should be scheduled for pick-up by EH&S.

Prior to EH&S pick up, please inspect all containers to make sure they are safe to transport. Verify each container has an accurate waste label, and the containers are clean and free of residue and do not show any signs of bulging, fuming, or bubbling. **EH&S may refuse to pick up waste that is not properly prepared.**

X. Accidents, Emergencies, and Chemical Spills

A. Regulatory Requirements

The necessary work practices, procedures, and policies outlined in this chapter are required by the following:

- *8 CCR §342*, "Reporting Work-Connected Injuries"
- *8 CCR §3320*, "Emergency Action Plan"
- *8 CCR §3211*, "Fire Prevention Plan"
- *8 CCR §5162*, "Emergency Eyewash and Shower Equipment"
- *8 CCR §5192*, "Hazardous Waste Operations and Emergency Response"

B. 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. 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.

For all incidents requiring emergency response, call 9-1-1.

C. Accidents

In the event of an injury or illness:

1. Seek medical attention if needed.
2. Notify the PI/Laboratory Supervisor immediately.
3. File a Worker's Compensation claim through *UCM Worker's Compensation Program*.

Serious injuries and illnesses require an immediate notification to Environmental Health and Safety at (209) 228-4234 during normal business hours or (209) 201-9820 after hours. The most common examples of a serious injury is anytime an employee is hospitalized, suffers permanent disfigurement (e.g., facial burn), loss of an eye, or amputation (bony involvement with a finger cut).

PIs/Laboratory Supervisors are responsible for ensuring that their employees receive appropriate medical attention in the event of an occupational injury or illness. All accidents and injuries requiring medical care must be reported to EH&S. At a minimum, each laboratory should have the following preparations in place:

1. Access to a first aid kit.
2. Posting of emergency telephone numbers and locations of emergency treatment facilities.
3. Training of staff to arrange an escort for injured personnel to the medical treatment site when possible and to provide medical personnel with copies of SDS(s) for the chemical(s) involved in the incident. For non-emergencies, you may use a personal vehicle instead of taking an ambulance.

ACCIDENT PREVENTION METHODS	
Do	**Don't**
• **Always** wear appropriate eye protection; • **Always** wear appropriate laboratory coat; • **Always** wear appropriate gloves; • **Always** wear closed-toe/closed-heel shoes and full length pants; • **Always** confine long hair and loose clothing; • **Always** use the appropriate safety controls (e.g., certified fume hoods); • **Always** label and store chemicals properly; • **Always** keep the work area clean and uncluttered. • **Always** have documented 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.	• **Never** enter the laboratory wearing inappropriate clothing (e.g., open-toe shoes and shorts); • **Never** work alone on procedures involving hazardous chemicals, biological agents, or other physical hazards unless approved by the PI/Laboratory Supervisor; • **Never** eat, drink, chew gum or tobacco, smoke, or apply cosmetics in the laboratory; • **Never** manipulate contact lenses in a laboratory; and • **Never** use damaged glassware or other equipment. • **Never** begin work on potentially hazardous activities, or if changes are made to procedures, without having any training on all aspects of lab safety relevant to the work and without proper documentation of training.

NOTE the *UC Center for Laboratory Safety* maintains a *website of Lessons Learned* from previous research-related incidents and injuries. Please review this information such that a known situation that previously resulted in an injury/incident at a previous institution is not repeated at UC Merced. By sharing this information at UC Merced, and throughout the UC system, we can aim to learn from previous events with the goal of preventing future recurrence.

If laboratory personnel experience a severe or life-threatening injury, or any other medical emergency, call **9-1-1** for emergency response.

Personnel with minor injuries should be treated with first aid kits as appropriate, and receive further evaluation and treatment when necessary, at:

1. *Occupational Health Clinic*, (209) 228-0100, in the Joseph Edward Gallo Health and Wellness Center, UC Merced campus.
2. *Health and Athletic Center*, (209)228-2273, in H. Rajender Reddy Health Center, UC Merced campus.

If the injury is work-related, please follow the instructions for *Worker's Compensation*. Please note that neither Occupational Health Clinic nor Health and Athletic Center offer emergency medical care. All acute emergencies should contact **9-1-1** or seek care at the nearest emergency room.

Note, if your work environment is not in close proximity to UC Merced's main campus you must provide laboratory personnel with guidance on the location and contact information for the most appropriate medical treatment facility to your location. This information shall be contained in either: A) laboratory-specific *SOPs*, or B) a *Laboratory Safety Plan Supplement*.

Serious occupational injuries, illnesses, and exposures to hazardous substances must be reported to EH&S at (209) 228-2EHS within eight 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, but are not limited to, amputations, lacerations with severe bleeding, burns, concussions, fractures, and crush injuries. As soon as PIs/Laboratory Supervisors are aware of a potentially serious injury, they must contact EH&S.

D. Laboratory Safety Equipment

New personnel must be instructed in the location of fire extinguishers, emergency eyewashes, safety showers, and other safety equipment *before* they begin work in the laboratory. This training is considered part of the laboratory-specific training all lab personnel must complete, and is outlined in the *Site-Specific Safety Orientation and Training Checklist for New Laboratory Personnel*. Existing equivalent checklists are also acceptable.

1. Fire Extinguishers

All laboratories working with combustible or flammable chemicals must be outfitted with appropriate fire extinguishers. All extinguishers must be mounted on a wall in an area free of clutter or stored in a fire extinguisher cabinet. Personnel should be familiar with the location, use, and classification of the extinguishers in their laboratory. A helpful overview video on laboratory fires and fire extinguishers is available from the *Dow Chemical Company* and *training on the proper operation of a fire extinguisher* is available from the UC Learning Center (*UCLC*).

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-sized fire).
- Appropriate training has been received.
- It is safe to do so.

- The person wishes to do so and is capable.

Any time a fire occurs, or 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 UC Merced Fire Department at 9-1-1 and or EHS at (209) 228-2EHS.

2. Safety Showers and Eyewash Stations

Immediate access to emergency eyewash stations and safety showers is required where the risk of chemical exposure can cause:

- eye damage
- severe irritation
- permanent tissue damage
- toxicity by absorption

Access must be available in **10 seconds** or less for a potentially injured individual; and access routes must be kept clear. The installation locations of emergency eyewashes and safety showers shall follow *8 CCR §5162* and the relevant sections of ANSI Z358.1 incorporated by reference. Safety showers must always have a minimum clearance of 16 inches from the centerline of the spray pattern in all directions; this means that no objects should be stored or left within this distance of the safety shower. Water hoses, sink faucets, or showers are not acceptable eyewash facilities. Additionally, portable keg-type shower/eyewash systems are only acceptable as a temporary solution and are not intended to replace plumbed emergency safety showers/eyewash stations.

In the event of contact with a chemical or substance, immediately irrigate the eyes and/or other parts of the body for **15 minutes**. Individuals using the emergency eyewash and/or safety shower should be assisted by an uninjured person to aid in decontamination and to encourage the individual to use the eyewash and/or shower for the full **15 minutes**. Clothing that has been in contact with hazardous materials **must** be removed. Fire blankets and clean lab coats may be used to cover the injured person for warmth and modesty. Medical attention must be sought immediately, and the event reported to the PI/Laboratory Supervisor and EH&S (209) 228-2EHS.

Safety shower/eyewash combination units are tested on a monthly basis.

3. Fire Doors

Many areas of research buildings contain critical fire doors as part of the building design. These doors are an important element of the fire containment system and shall remain **closed** unless they are held open by an electromagnetic releasing system integrated with the building fire detection system.

E. 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** to notify the UCPD
2. Evacuate and isolate the area

    - 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.
    - If possible, shut off equipment before leaving
    - Close doors and/or fume hood sash

3. Remain safely outside the affected area to provide details to emergency responders.
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 in 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 (209) 228-2EHS within 8 hours every time a fire extinguisher is discharged.

Immediately report any fire or fire extinguisher discharge, even if the fire is extinguished, to the UC Merced Police Department and the PI/Laboratory Supervisor.

F. Chemical Spills

Chemical spills, or release of gas, chemical smoke, or vapor, can result in chemical exposures and contaminations. These incidents 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 safety 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.

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.

HIGHLY TOXIC CHEMICAL SPILLS

Do not try and clean up spills of any size. All spills of these materials require emergency response.

- Aromatic amines
- Bromines
- Cyanides
- Carbon disulfide
- Organic halides
- Hydrazine
- Nitriles
- Ethers
- Nitro-compounds

1. What to Do: Small Chemical Spill (< 1 Liter)

- Evacuate all non-essential persons from the spill area.
- If needed, call for medical assistance by dialing 9-1-1.
- Help anyone who may have been contaminated. Use emergency eyewashes/showers by flushing the skin or eyes for **at least 15 minutes**. Seek medical attention following use of the eyewash/safety shower.
- Post someone just outside the spill area to keep people from entering. Avoid walking through contaminated areas.
- Before attempting to clean-up a spill, you must have the proper protective equipment (including safety goggles, gloves and a laboratory coat or other protective garment) and appropriate clean-up materials. Check the chemical's SDS in your laboratory or *online* for spill clean-up procedures or call EH&S at (209) 228-2EHS for guidance.
- Turn off potential ignition sources (e.g., open flames, electrical heaters, and other electrical equipment), and close valves on compressed gas cylinders if the chemical is flammable.
- 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, do not attempt to clean it up. Call for emergency personnel to provide HazMat response.
- 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 chemical spill kit to neutralize and absorb inorganic acids and bases. For other chemicals, use the appropriate spill kit or absorb the chemical with sorbent pads, paper towels, vermiculite, dry sand, or diatomaceous earth.
- Collect the residue and place it in a clear plastic bag. Double bag the waste and label the bag with a properly completed *Hazardous Waste label*.

Note, solid spills are not typically emergencies. If the chemical is toxic, use damp paper towels to transfer it into plastic bags, **DO NOT** dry sweep.

FACTORS TO CONSIDER BEFORE SPILL CLEAN-UP

- Spill location
- Size of spill area
- Toxicity
- Volatility
- Flammability and presence of ignition sources
- Availability of spill clean-up materials, including proper PPE
- Training of responders

2. What to Do: Large Chemical Spill (>1 Liter)

Large chemical spills require emergency response. Call 9-1-1. If the spill presents a situation that is 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.
- As you evacuate the laboratory, close the door behind you, and:
    - Post someone at a safe distance from the spill area to keep people from entering the spill area.
    - Confine the spill area if possible and safe to do so.
    - Leave on or initiate 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.

G. Earthquake

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

1. Take cover under a desk or strong doorframe during the shaking.
2. Remain under cover indoors until the shaking subsides. Evacuate the building only once the shaking has ceased.
3. Report any injuries or broken utility services to 9-1-1.
4. Assist any injured individuals with receiving medical attention.
5. Be prepared for these events. Know your lab's Emergency Action Plan.