UCLA Chemical Hygiene Plan

2017

UCLA
ENVIRONMENT,
HEALTH & SAFETY

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LAB SAFETY AT UCLA

Laboratories are unique workplaces that, in many cases, pose an elevated level of risk to personnel who work there. It is because of this that UCLA has developed a robust and comprehensive lab safety program to ensure that risks to personnel health and safety, risk to campus infrastructure and property, and risk to the local environment and community are minimized.

While UCLA is held to the minimums of state and federal regulations, it will also impose internally created restrictions to further guarantee the minimization of risk. UCLA-specific policies and practices are developed through cooperation between campus administration and the research community. The University and the administration of UCLA are represented in safety-related matters by the office of Environment, Health and Safety (EH&S), while the faculty and research community are represented through several faculty-led UCLA Safety & Compliance committees. Through a collaborative effort between the administration and the faculty, UCLA hopes to create a positive culture of safety in the laboratory.

The practices and policies of EH&S are explained in detail within the Chemical Hygiene Plan, Radiation Safety Manual, Laser Safety Manual, and the Biosafety Manual. The UCLA Safety and Compliance Committees functions and purposes are described below.

UCLA SAFETY & COMPLIANCE COMMITTEES

The following faculty-led committees were established by the UCLA Office of the Vice Chancellor for Research as the local review bodies responsible for oversight of safety and compliance functions of all research activities conducted at UCLA.

ANIMAL RESEARCH COMMITTEE (ARC)

The UCLA ARC is an independent research review committee mandated by the Animal Welfare Act and the PHS Policy on Humane Care and Use of Laboratory Animals (PHS Policy,http://grants.nih.gov/grants/olaw/references/phspolicylabanimals.pdf). The ARC, through the experience and expertise of its members, is charged with the responsibility to oversee the entire animal care and use program at UCLA with an emphasis on ensuring that animal welfare issues are addressed. http://ora.research.ucla.edu/oaro; email: oaro@research.ucla.edu

CHEMICAL AND PHYSICAL SAFETY COMMITTEE (CPSC)

The UCLA CPSC is charged with promoting a safe working environment with respect to chemical and physical hazards in all research and teaching laboratories on campus, as well as shops that support research activities. As part of its charge, the CPSC reviews the lab safety inspection process, the Chemical Hygiene Plan, and incident investigations. The committee is also empowered to establish inspection criterion and effectively set general lab safety rules. http://ora.research.ucla.edu/SafetyCommittee/CPSC; email: cpsc@research.ucla.edu

INSTITUTIONAL BIOSAFETY COMMITTEE (IBC)

The UCLA IBC was established as the local review body responsible for oversight of all research activities involving the use of hazardous biological material and recombinant or synthetic nucleic acids, as required and outlined in the NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules(http://osp.od.nih.gov/sites/default/files/NIH_Guidelines.html) and the CDC/NIH Biosafety in Microbiological and Biomedical Laboratories (BMBL, http://www.cdc.gov/biosafety/publications/bmbl5/). The IBC is responsible for establishing, monitoring, and enforcing policies and procedures involving hazardous biological materials and recombinant/synthetic nucleic acids to meet applicable federal, state, local and institutional regulations and guidelines.
http://ora.research.ucla.edu/SafetyCommittee/IBC/; email: OIBC@research.ucla.edu

RADIATION SAFETY COMMITTEES (RSCS)

At UCLA, the Radiation Safety Committee (RSC) and the four subcommittees are responsible for the policies and procedures pertaining to the use of radiation for research and medical purposes. http://ora.research.ucla.edu/SafetyCommittee/RSC/Pages/RSC.aspx; email: orsc@research.ucla.edu

- **Academic Radiation Safety Committee (ARSC)** is responsible for ensuring the safe conduct of radiological procedures in non-human indications. http://ora.research.ucla.edu/SafetyCommittee/RSC/Pages/ARSC.aspx
- **Clinical Operations Radiation Safety Committee (CORSC)** is responsible for ensuring the safe conduct of radiological procedures in clinical care. http://ora.research.ucla.edu/SafetyCommittee/RSC/Pages/CORSC.aspx
- **Medical Radiation Safety Committee (MRSC)** is responsible for the evaluation of all proposals that involve radiological procedures in medical research at UCLA. The MRSC ensures that the University is in compliance with the policies and procedures outlined in the California Code of Regulations, Title 17 §30100 and conditions of UCLA's Radioactive Materials license, #1335-19. http://ora.research.ucla.edu/SafetyCommittee/RSC/Pages/MRSC.aspx

- **Radioactive Drug Research Committee (RDRC)** operates under the provisions of 21 CFR 361.1 and is responsible for the evaluation of all proposals that involve the use of radioactive drugs in humans without an IND when the drug is administered under certain conditions outlined in the Office of Radiation Safety Committees website. http://ora.research.ucla.edu/SafetyCommittee/RSC/Pages/RDRC.aspx

LASER SAFETY COMMITTEE (LSC)

The UCLA Laser SC is responsible for making recommendations, providing guidance, and implementing safety policies and practices on laser systems that are used in Research, Engineering and Education at UCLA acquired through purchase, transfer or assembly. http://ora.research.ucla.edu/ORSC/Pages/RDRC.aspx; email:lasersafety@ehs.ucla.edu

INSTITUTIONAL REVIEW BOARDS (IRBS)

The UCLA IRBs are required by the Department of Health and Human Services/Office of Human Research Protections (DHHS/OHRP) to review all human subjects research activities conducted at UCLA. The function of the IRBs is to ensure adherence to all federal, state, local, and institutional regulations concerning the protection of human subjects in research. UCLA IRB review is required for both funded and non-funded human subjects' research. There are five IRBs with each specializing in certain types of research:

- **North General IRB (NGIRB)** reviews research from the College of Letters & Science and the Professional Schools.
- **South General IRB (SGIRB)** reviews social-behavioral research from the Schools of Public Health, Nursing, and Medicine.
- **Medical IRB1 (MIRB1)** reviews general and internal medicine, infectious diseases, and dental and ophthalmologic research.
- **Medical IRB2 (MIRB2)** reviews oncology and hematology research.
- **Medical IRB3 (MIRB3)** reviews neuroscience, neurology, psychiatric, drug abuse, and related behavioral science research.

http://ora.research.ucla.edu/ohrpp/Pages/OHRPPHome.aspx; email: gcirb@research.ucla.edu for NGIRB or SGIRB; email: mirb@research.ucla.edu for MIRB1, 2, and 3.

EMBRYONIC STEM CELL RESEARCH OVERSIGHT (ESCRO)

The UCLA Embryonic Stem Cell Research Oversight (ESCRO) committee is to provide oversight of human embryonic stem cell (HESC) research and other stem cell research covered by the California Institute for Regenerative Medicine (CIRM) and California Department of Public Health (CDPH) regulations in order to ensure that UCLA research meets the highest scientific and ethical standards.

https://www.stemcell.ucla.edu/oversight-review, email: speckman@mednet.ucla.edu

OFFICE OF THE VICE CHANCELLOR FOR RESEARCH SAFETY OVERSIGHT COMMITTEE (OSOC)

OSOC is staffed with the Chairs of the CPSC, IBC, LSC and RSC; the Assistant Vice Chancellor of Environment, Health & Safety; a delegate from the Office of the Vice Chancellor for Legal Affairs; and the Associate Vice Chancellor for Research - Laboratory Safety. The OSOC is charged with promoting a safe working environment in all research and teaching laboratories on campus. Specifically, the OSOC serves as a mechanism for communication between existing campus Safety Committees on topics of mutual safety concerns. The Committee advises and reports to the Chancellor through the Vice Chancellor for Research.
http://ora.research.ucla.edu/SafetyCommittee/Pages/index.aspx

ANCILLARY DEPARTMENT SAFETY COMMITTEE

Department-based safety committees are important for a successful campus-wide program. While not mandated, implementation of departmental safety committees is highly recommended. Departmental Safety Committees are responsible for developing, implementing and maintaining the departmental Injury and Illness Prevention Program (IIPP – a state-mandated program under Cal/OSHA (Title 8, CCR Section 3203) as well as identifying, correcting and communicating hazards specific to the department.

The following table illustrates the programs within the Office of Environment, Health & Safety and their relationship to the various committees outlined above:

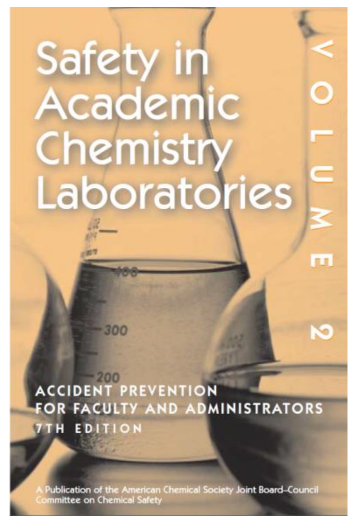
	ARC	CPSC	IBC	IRB	LSC	RSC
BIOSAFETY	O		X	O		
LABORATORY SAFETY	O	X				
LASER SAFETY					X	
RADIATION SAFETY	O			O		X

X= direct interaction   O= involvement but no direct reporting

CHAPTER 1: INTRODUCTION

PURPOSE

UCLA is committed to providing a healthy and safe working environment for the campus community, free from recognized hazards in accordance with UCLA Policy 811 (http://www.adminpolicies.ucla.edu/pdf/811.pdf).The Chemical Hygiene Plan (CHP) establishes a formal written program for protecting laboratory personnel against adverse health and safety hazards associated with exposure to potentially hazardous chemicals and must be made available to all employees working with hazardous chemicals. The CHP describes the proper use and handling practices and procedures to be followed by faculty, staff, students, visiting scholars, volunteers, and all other personnel working with potentially hazardous chemicals in laboratory settings. This plan is based on best practices identified in, among others sources, "Prudent Practices for Handling Hazardous Chemicals in Laboratories (https://ucla.app.box.com/ehs-prudent-lab-practices)," published by the National Research Council and the American Chemical Society's "Safety in Academic Chemistry Laboratories (https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/safety-in-academic-chemistry-laboratories-faculty.pdf)."



SCOPE

The CHP applies to all laboratories that use, store or handle potentially hazardous chemicals and all personnel who work in these facilities. 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 (http://www.ehs.ucla.edu/doc/radiation-safety-manual-pdf) and Biosafety Manual (https://www.ehs.ucla.edu/research/bio/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 information presented in the CHP represents best practices and provides a broad overview of the information necessary for the safe operation of laboratories that utilize potentially hazardous chemicals. It is not intended to be all inclusive. Departments, divisions or other work units engaged in work with potentially hazardous chemicals that have unusual characteristics, or are otherwise not sufficiently covered in the written CHP, must customize the document by adding additional sections addressing the hazards and how to mitigate their risks, as appropriate. Such customizations must receive prior approval from the PI/Laboratory Supervisor and/or the UCLA Office of Environment, Health and Safety (EH&S). See Appendix C: Policy 907 – Safe Handling of Particularly Hazardous Substances (http://www.adminpolicies.ucla.edu/app/Default.aspx?&id=907) for additional information on substances that may trigger these additions. For information on specific chemical safety topics not covered in the CHP, please contact **EH&S at 310-825-5689** or laboratorysafety@ehs.ucla.edu .

REGULATORY REQUIREMENTS

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

- *Assembly Bill 2286 (http://www.calepa.ca.gov/CUPA/Documents/eReporting/AB2286.pdf)*
- *Title 8, CCR Section 3380- 3387, Personal Protective Equipment (https://www.dir.ca.gov/title8/sb7g2a10.html)*
- *Title 8, CCR, Section 5154.1, "Ventilation Requirements for Laboratory-Type Hood Operations" (http://www.dir.ca.gov/title8/5154_1.html)*
- *Title 8, CCR, Section 5164, "Storage of Hazardous Materials"* (http://www.dir.ca.gov/title8/5164.html)
- *Title 8, CCR, Section 5191, "Occupational Exposures to Hazardous Chemicals in Laboratories* (http://www.dir.ca.gov/title8/5191.html)*"*
- *Title 8, CCR, Section 5194, "Hazard Communication" (*http://www.dir.ca.gov/title8/5194.html)
- *Title 8, CCR, Section 5209, "Carcinogens"* (http://www.dir.ca.gov/title8/5209.html)
- *Title 8, CCR, Section 5538, "Office, Educational and Institutional Occupancies" (https://www.dir.ca.gov/title8/5538.html)*
- Title 29 CFR 1910.1450 "*Occupational Exposure to Hazardous Chemicals in Laboratories*" *(https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10106&p_table=STANDARDS)*

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

RIGHTS AND RESPONSIBILITIES

Employees and other personnel who work in laboratories have the right to be informed about the potential hazards of the chemicals in their work areas and to be properly trained to work safely with these substances. This includes custodial staff and other personnel who work to clean and maintain laboratories. Employees have the right to file a complaint with Cal/OSHA if they feel they are being exposed to unsafe or unhealthy work conditions and cannot be discharged, suspended, or otherwise disciplined by their employer for filing a complaint or exercising these rights. *All personnel working with potentially hazardous chemicals are encouraged to report (anonymously, if preferred) any concerns about unsafe work conditions to the* ***EH&S Hotline at 310-825-9797***.

Responsibility for the health and safety of the campus community extends to the highest administrative levels of UCLA. The Chancellor and Vice Chancellors are responsible for the implementation of UCLA's Environmental Health and Safety Policy (http://www.adminpolicies.ucla.edu/pdf/811.pdf) at all facilities and properties under campus control. The Chemical and Physical Safety Committee (http://ora.research.ucla.edu/SafetyCommittee/CPSC/Pages/home.aspx) (CPSC) is a faculty led committee that will advise the Vice Chancellor of Research regarding compliance with safety related policies. Deans and Department 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 UCLA'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, including PIs/Laboratory Supervisors, employees, and students, have a duty to fulfill their obligations with respect to maintaining a safe work environment.

All employees and other personnel working with potentially hazardous chemicals have the responsibility to conscientiously participate in training seminars on general laboratory safety and review and be familiar with the contents of the CHP. Those working with chemicals are responsible for staying informed about the chemicals in their work areas, safe work practices and proper personal protective equipment (PPE) required for the safe performance of their job. Failure to comply with these requirements will result in progressive disciplinary action in accordance with University policy (Chapter 8), and may result in temporary suspension of laboratory activities until corrective action is implemented.

RESPONSIBILITIES OF PRINCIPAL INVESTIGATOR (PI)/ LABORATORY SUPERVISOR

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

1. Knowing all applicable health and safety rules and regulations, training and reporting requirements and standard operating procedures associated with chemical safety for regulated substances;
2. Identifying hazardous conditions or operations in the laboratory or other facility containing hazardous chemicals and determining safe procedures and controls, and implementing and enforcing standard safety procedures;
3. Establishing standard safety operating procedures (general and protocol specific) and performing literature searches relevant to health and safety for laboratory-specific work;
4. Providing prior-approval for the use of hazardous chemicals in the PI/Laboratory Supervisor's laboratory or other facility with hazardous chemicals;
5. Consulting with EH&S and/or Departmental Safety Committee on use of higher risk materials, such as use of particularly hazardous substances, as defined by UCLA Policy 907 (Appendix C), or conducting higher risk experimental procedures so that special safety precautions may be taken;
6. Maintaining an updated chemical inventory for the laboratory or facility (Chapter 5);
7. Ensuring laboratory or other personnel under his/her supervision have access to and are familiar with the appropriate Safety Manual(s);
8. Training all laboratory or other personnel he/she supervises to work safely with hazardous materials and maintain written records of laboratory-specific or other specialized training in the appropriate Safety Manual(s). Electronic records of training are encouraged. Training must include information of the location and availability of hazard information (Chapter 7);
9. Promptly notifying EH&S (310-825-9797) and/or Facilities Management (310-825-9236) should he/she become aware that work place engineering controls (e.g., fume hoods) and safety equipment (e.g., emergency showers/eyewashes, fire extinguishers, etc.) become non-operational;
10. Ensuring the availability of all appropriate personal protective equipment (PPE) (e.g., laboratory coats, gloves, eye protection, etc.) and ensuring the PPE is maintained in working order (Appendix B);
11. Conducting periodic self-inspections of laboratory (Appendix D) or facility and maintaining records of inspections, as required;
12. Promptly reporting accidents and injuries to EH&S. Serious injuries MUST be reported to EH&S **(310-825-9797)** 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;

13. Providing funding for medical surveillance and/or medical consultation and examination for laboratory and other personnel, as required;
14. 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; and
15. Identifying and minimizing potential hazards to provide a safe environment for repairs and renovations.

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 and following requirements of the CHP and all appropriate Safety Manuals and Policies;
2. Following all verbal and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned;
3. Developing good personal chemical hygiene habits, including but not limited to, keeping the work areas safe and uncluttered;
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, personal protective equipment, and administrative controls;
6. Understanding the capabilities and limitations of PPE issued to them;
7. Gaining prior approval from the PI/Laboratory Supervisor for the use of restricted chemicals and other materials;
8. Consulting with PI/Laboratory Supervisor before using particularly hazardous substances (PHS), explosives and other highly hazardous materials or conducting certain higher risk experimental procedures;
9. Properly storing, identifying, handling, and disposing of hazardous waste;
10. Immediately reporting all accidents and unsafe conditions to the PI/Laboratory Supervisor;
11. Completing all required health, safety and environmental training and providing written documentation to their supervisor;
12. Participating in the medical surveillance program, when required;

13. Informing the PI/Laboratory Supervisor of any work modifications ordered by a physician as a result of medical surveillance, occupational injury or exposure; and
14. When working autonomously or performing independent research or work:
    a. Reviewing the plan or scope of work for their proposed research with the PI/Laboratory Supervisor
    b. Notifying in writing and consulting with the PI/Laboratory Supervisor, in advance, if they intend to significantly deviate from previously reviewed procedures (Note: Significant change may include, but is not limited to, change in the objectives, change in PI, change in the duration, quantity, frequency, temperature or location, increase or change in PPE, and reduction or elimination of engineering controls.)
    c. Preparing SOPs and performing literature searches relevant to safety and health that are appropriate for their work; and
    d. Providing appropriate oversight, training and safety information to laboratory or other personnel they supervise or direct.

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. In case of life safety matters or imminent danger to life or health, the Director of EH&S or designee has the authority to order the cessation of the activity until the hazardous condition is abated. EH&S provides technical guidance to personnel at all levels of responsibility on matters pertaining to laboratory use of hazardous materials. The CHO is a member of EH&S and, with support from other EH&S personnel, is responsible for:

1. Informing PIs/Laboratory Supervisors of all health and safety requirements and assisting with the selection of appropriate safety controls, including laboratory and other workplace practices, personal protective equipment, engineering controls, training, etc.;
2. Conducting periodic inspections and immediately taking steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards;
3. Performing hazard assessments, upon request;
4. Obtaining and utilizing, when necessary, area and personal exposure monitoring records;

5. Helping to develop and implement appropriate chemical hygiene policies and practices;
6. Having working knowledge of current health and safety rules and regulations, training, reporting requirements and standard operating procedures associated with regulated substances. Such knowledge may be supplemented and developed through research and training materials;
7. Working with Departmental Safety Committee to review existing and developing new SOPs for handling hazardous chemicals;
8. Providing technical guidance and investigation, as appropriate, for laboratory and other types of accidents and injuries;
9. Helping to determine medical surveillance requirements for potentially exposed personnel;
10. Reviewing plans for installation of engineering controls and new facility construction/renovation, as requested;
11. Reviewing and evaluating the effectiveness of the CHP at least annually and updating it as appropriate; and
12. Providing management oversight and assistance with environmental compliance, transport and disposal of hazardous waste.

RESPONSIBILITIES OF THE CHEMICAL AND PHYSICAL SAFETY COMMITTEE (CPSC)

1. The CPSC will develop, recommend, update and maintain policies and procedures applicable to chemical and physical health and safety practices at UCLA in order to promote safe research practices.
2. The CPSC will advise the Vice Chancellor for Research regarding compliance with safety related policies.
3. The CPSC will receive and review summary reports from the Office of Environment, Health and Safety (EH&S) laboratory safety inspections and incident reports related to chemical and physical hazards.
4. The CPSC will review findings of inspection and hazard surveillance programs carried out by authorized EH&S personnel and State and Federal Regulatory authorities.
5. The CPSC will receive and review reports from Departmental Health and Safety Committees as well as receive input from individual Faculty and Researchers.
6. The CPSC will establish and review strategies to ensure ongoing and adequate surveillance, hazard identification, and risk evaluation of laboratory activities related to chemical and physical hazards.

7. The CPSC will review annually the campus Laboratory Safety Manual, advise the Vice Chancellor for Research and Director of EH&S regarding its effectiveness, and propose improvements as necessary.
8. The CPSC will review requests for variances from established campus safety practices. The reviews for such requests could include consideration of regulatory requirements, analyses of risk assessments completed by EH&S, and consultations with EH&S, Campus Counsel, and OVCR Safety Oversight Committee (OSOC). After review, the CPSC will make recommendations to the Vice Chancellor for Research on accepting or not accepting these requests.

ADDITIONAL RESOURCES FOR PRINCIPAL INVESTIGATORS

EH&S has published numerous factsheets and other resources to assist PIs and lab personnel. See below for important links.

- PI/ Lab Supervisor's Responsibilities (http://www.ehs.ucla.edu/doc/LabSafetyOrientation.pdf/view)
- Lab Set up Checklist (https://ucla.app.box.com/ehs-setting-up-a-lab)
- Lab Hazard Assessment Tool (LHAT) (http://lsm.ehs.ucla.edu/)
- EH&S Safety Training Matrix (https://ucla.app.box.com/ehs-lab-training-matrix)
- Site Specific Training form (https://ucla.app.box.com/ehs-training-roster-group)
- Site Safety Orientation Checklist (https://ucla.app.box.com/ehs-site-safety-checklist)
- Employee Training History form (https://ucla.app.box.com/ehs-training-history-ee)

UNIVERSITY OF CALIFORNIA POLICIES

Effective on October 31st, 2013, two UC-wide Policies (https://www.ehs.ucla.edu/research/lab/policies) were enacted by UC Office of the President. The first policy involves minors in the laboratory and the second policy regards laboratory safety training

- UCOP Minors in Laboratories and Shops Policy (http://policy.ucop.edu/doc/3500602/MinorsLabsShops)
- UCOP Lab Safety Training Policy (http://policy.ucop.edu/doc/3500598/LabSafetyTraining)

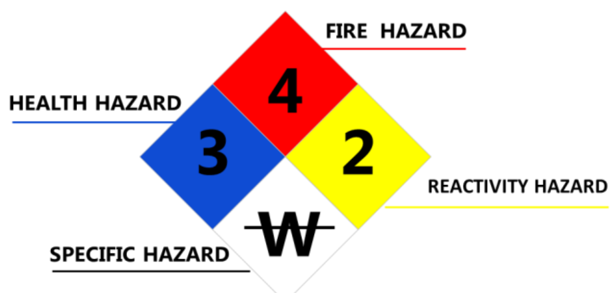
CHAPTER 2: CLASSES OF HAZARDOUS CHEMICALS

IDENTIFICATION & CLASSIFICATION OF HAZARDOUS CHEMICALS

Chemicals can be divided into several different hazard classes. The hazard class will determine how these materials should be stored and handled and what special equipment and procedures are needed to use them safely. Each chemical container, whether supplied by a vendor or produced in the laboratory, must include labels that clearly identify the hazards associated with that chemical. In addition to specific chemical labels, hazard information for specific chemicals can be found by referencing the Safety Data Sheet (SDS) for that chemical.

Rooms containing hazardous chemicals must be labeled with a National Fire Prevention Association (NFPA) door placard that gives an overview of the key chemical hazards contained within that room. These postings have the familiar four colors, 0-4 number rating that quickly supplies the hazard information broken down into four hazard classes, with 0 indicating a low level of hazard and 4 indicating a high hazard level. The four chemical hazard types correspond to the four color areas: red indicates a flammability hazard, yellow indicates a reactive hazard, blue indicates a health hazard and the white area is reserved for special hazards that are identified by hazard symbols or labels to indicate hazards such as radioactivity, biohazard, water reactive chemicals, etc. Each of these hazards has a different set of safety precautions associated with them. Figure 2.1 illustrates the NFPA rating system.

Figure 2.1 – NFPA Door Posting



HEALTH	FIRE	REACTIVITY	SPECIFIC
[4] Deadly	**[4]** Extremely flammable	**[4]** May detonate	ACID - Acid
[3] Extreme danger	**[3]** Ignites at normal temperature	**[3]** Shock and heat may detonate	ALK – Alkali
[2] Hazardous	**[2]** Ignites when moderately heated	**[2]** Violent chemical change	COR – Corrosive
[1] Slightly hazardous	**[1]** Must be preheated to burn	**[1]** Unstable if heated	OXY – Oxidizer
[0] Normal material	**[0]** Will not burn	**[0]** Stable	P – Polymerization
			– Radioactive
			W – Use no water

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 new chemical compounds be treated as if they were potentially harmful and to use appropriate eye, inhalation and skin protection equipment.

FLAMMABILITY HAZARDS

A number of highly flammable substances are in common use in campus laboratories. Flammable liquids include those chemicals that have a flashpoint of less than 100 degrees Fahrenheit. These materials must be stored in flammable storage cabinets if aggregate quantities of **10 gallons/room** or more are stored in the lab and if the container size is greater than **1 gallon (4 L)**. Flame-resistant laboratory coats must be worn when working with flammable materials and/or with procedures where a significant fire risk is present (e.g., when working with open flame, etc.) as described in UCLA Policy 905 (Appendix B). 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.

REACTIVITY 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 a laboratory grade refrigerator or freezer that is designed for storing 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 must always be worn when working with pyrophoric chemicals. Pyrophorics must also always be handled in laboratories located within buildings that are fully equipped with emergency sprinkler systems. Inquiries into laboratories that meet this requirement can be directed to Chemical Safety by email at chemsafety@ehs.ucla.edu.

CORROSIVE SUBSTANCES

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

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

Symptoms of exposure for inhalation include a burning sensation, coughing, wheezing, laryngitis, shortness of breath, nausea, and vomiting. For eyes, symptoms include pain, blood shot eyes, tearing, 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.

HEALTH HAZARDS

Cal/OSHA uses the following definition for health hazards:

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

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

IRRITANTS

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

SENSITIZERS

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

HAZARDOUS SUBSTANCES WITH TOXIC EFFECTS ON SPECIFIC ORGANS

Substances included in this category include:

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

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

PARTICULARLY HAZARDOUS SUBSTANCES

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.

See UCLA’s Policy 907: Particularly Hazardous Substances Policy (Appendix C) for more information, which also includes a list of common particularly hazardous chemicals used inside laboratories.

Particularly hazardous substances are divided into three primary types:

1. **Acute Toxins**
2. **Reproductive Toxins**
3. **Carcinogens**

Acute Toxins

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

Reproductive Toxins

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

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

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

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 three classes:

1. **Select Carcinogens;**
2. **Regulated Carcinogens;**
3. **Listed Carcinogens**

Select Carcinogens are materials which have met certain criteria established by the National Toxicology Program or the International Agency for Research on Cancer regarding the risk of cancer via certain exposure routes. (See definition Select Carcinogen). 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 (https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10007&p_table=standards)
- Annual Report on Carcinogens published by the National Toxicology Program (NTP), including all of the substances listed as "known to be carcinogens" and substances listed as "reasonably anticipated to be carcinogens" (http://ntp.niehs.nih.gov/pubhealth/roc/roc13/index.html)
- International Agency for Research on Cancer (IARC), including all of Group 1 "carcinogen to humans", Group 2A "probably carcinogenic to humans" and 2B "possibly carcinogenic to humans" (http://monographs.iarc.fr/ENG/Monographs/PDFs/index.php)

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. A complete list of Regulated Carcinogens can be found in Appendix C.

Listed Carcinogens is a term referring to a list of thirteen specific chemicals that are the highest hazard class of carcinogens that have further requirements in addition to those of regulated carcinogens. Given these strict regulations for Listed Carcinogen use, handling, and/or storage, UCLA's EH&S must be contacted *before* any work with these agents begins. A list of Listed Carcinogens can be found in Appendix C.

Regulation citation: https://www.dir.ca.gov/title8/5209.html

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 (http://oehha.ca.gov/prop65/prop65_list/Newlist.html). This 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.

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 – 100 nm). 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 2.2).

Table 2.2 Types of Nanomaterials (from page 5 of Nanotoolkit)

Carbon Based	**Buckyballs or Fullerenes, Carbon Nanotubes*, Dendrimers** *Often includes functional groups like* PEG (polyethylene glycol), Pyrrolidine, N, N-dimethylethylenediamine, imidazole*
Metals and Metal Oxides	**Titanium Dioxide (Titania)**, Zinc Oxide, Cerium Oxide (Ceria), Aluminum oxide, Iron Oxide, Silver, Gold, and Zero Valent Iron (ZVI) nanoparticles**
Quantum Dots	**ZnSe, ZnS, ZnTe, CdS, CdTe, 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).*

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 (Table2.3). 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).

For further information see Appendix E: California Nanosafety Consortium of Higher Education's "Nanotoolkit: Working Safely with Engineered Nanomaterials in Academic Research Settings" (https://ucla.box.com/ehs-nanomaterials-toolkit),the National Institute of Occupational Safety & Health's (NIOSH) "Safe Practices for Working with Engineered Nanomaterials in Research Laboratories" (http://www.cdc.gov/niosh/docs/2012-147/pdfs/2012-147.pdf), and the National Institute of Occupational Safety & Health's (NIOSH) "Current Strategies for Engineering Controls in Nanomaterial Production and Downstream Handling Processes" (http://www.cdc.gov/niosh/docs/2014-102/pdfs/2014-102.pdf)

Table 2.3 Nanomaterial Risk Categories (from page 10 of Nanotoolkit)

RISK LEVEL	MATERIAL STATE OR TYPE OF USE	EXAMPLE
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) Types 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

Please see Appendix F for additional information of the hazard classes and standard operating procedures for handling these chemicals.

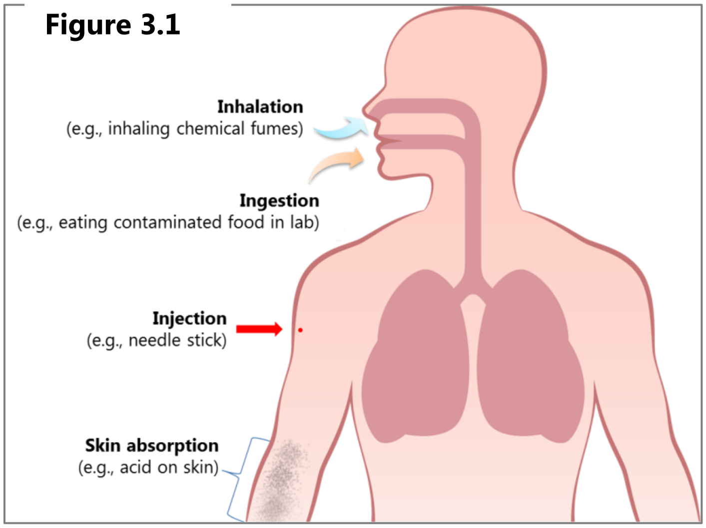
CHAPTER 3: HOW TO REDUCE EXPOSURES TO HAZARDOUS CHEMICALS

INTRODUCTION

Hazardous chemicals require a carefully considered, multi-tiered approach to ensure safety. There are four primary routes of exposure for chemicals which have associated health hazards (illustrated in Figure 3.1):

1. Inhalation;
2. Absorption (through the skin or eyes);
3. Ingestion; and
4. Injection (skin being punctured by a contaminated sharp object or uptake through an existing open wound).

Figure 3.1



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

SAFETY CONTROLS

Safety controls are divided into three main classifications:

1. Engineering Controls;
2. Administrative Controls; and
3. Protective Apparel and Equipment.

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

ENGINEERING CONTROLS

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

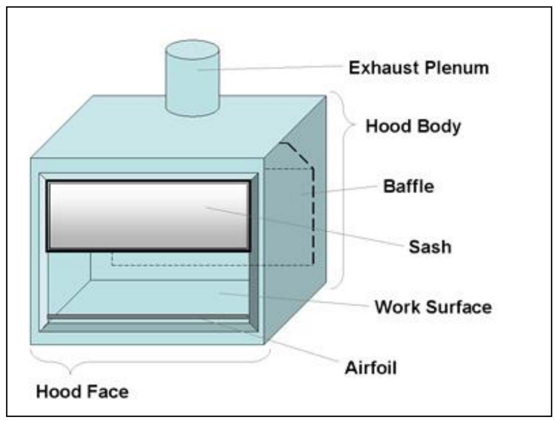
General Laboratory Ventilation

All laboratory rooms in which hazardous materials are used must have fresh air ventilation with 100% of the exhaust venting to the outside; laboratory rooms should not be part of recycled air systems. In cases where this is not desirable, 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 University of California Environment, Health and Safety (EH&S) Laboratory Safety Design Guide (http://www.ucop.edu/risk-services/_files/labdesign_guide.pdf) for additional information on laboratory ventilation.

FUME HOODS

Fume hoods are the most commonly used local exhaust system on campus. Other methods include vented enclosures for large pieces of equipment or chemical storage, and portable exhaust systems for capturing contaminants near the point of release. Some systems are equipped with air cleaning devices (HEPA filters or carbon absorbers). Exhaust from fume hoods 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 3.2 displays the key components of a fume hood.

Figure 3.2 – Fume Hood



It is advisable to use a fume hood when working with all hazardous substances. In addition, a fume hood or other suitable containment device must be used for all work with "particularly hazardous substances." A properly operating and correctly used fume hood can reduce or eliminate gases from volatile liquids, dusts and mists. Fume hoods are evaluated for operation and certified by EH&S on an annual basis. These annual evaluations check the fume hood air flow velocity to ensure that the unit will contain hazardous vapors. Data on annual fume hood monitoring is maintained by EH&S. A complete report of fume hood monitoring data must be kept for one year; summary data must be maintained for 5 years.

Each fume hood should have a current calibration sticker and a marker indicating the highest sash height to be used when working with hazardous materials. Contact EH&S (**310-825-9797**) 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 (lfm) with a minimum of 70 lfm for any measurement. The average face velocity should not exceed 160 lfm.

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

General Rules for Fume Hood Use

The following general rules should be followed when using laboratory hoods

1. Fume hoods should not be used for work involving hazardous substances unless they have a certification label that confirms certification has occurred within the past year
2. Always keep hazardous chemicals >6 inches behind the plane of the sash
3. **Never** put your head inside an operating laboratory hood. The plane of the sash is the barrier between contaminated and uncontaminated air
4. Work with the hood sash in the **lowest practical position.** The sash acts as a physical barrier in the event of an accident. Keep the sash closed when not conducting work in the hood
5. Do not clutter your hood with unnecessary bottles or equipment. Keep it clean and clear. Only materials actively in use should be in the hood

Routine maintenance and repairs of fume hoods are conducted by Facilities Management. Fume hood users may route requests for hood repair directly to Facilities via Facilities Service Requests (http://www.troublecall.admin.ucla.edu/tcall_plsql/pkg_tc.newTicket) also known as a FSR or by calling (310)825-9236. Make sure to indicate that the FSR has been "generated as a result of a health and safety deficiency" and mark it "urgent" in order to expedite processing. EH&S does not initiate maintenance but will coordinate with Facilities Management to ensure that it is completed. Upon reported completion by Facilities, EH&S will re-inspect the fume hood following maintenance or repairs.

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 listed carcinogens (as listed in the UCLA Particularly Hazardous Substances Policy) have additional requirements, , contact the **EH&S Hotline at 310-825-9797** if the intended use changes.

Fume Hood Inspections	
Step 1 – Physical Inspection	***Step 2 – Hood Performance Inspection***
Evaluates the physical condition of the hood and the materials being used in the hood. This includes checking for: • Improper storage of materials inside the fume hood • Use of proper materials • General hood cleanliness • Physical damage to the fume hood (e.g., broken sash) • Fully functioning lighting, fume hood indicator, airflow monitor, and alarm	Evaluates the overall hood performance to ensure that it is functioning properly. This involves checking the: • Average face velocity and set minimum face velocity, which is used to determine the rating of the hood and what the hood can be used for • Noise generated by the fume hood, to ensure that it is below 85 dB (only upon request) • If fume hood does not pass inspection, it will be labeled with a "DO NOT USE" sign until it can be repaired.

GLOVE BOXES AND VENTILATION DEVICES

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

Other Engineering Controls

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

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

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

ADMINISTRATIVE CONTROLS

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

EH&S requires that each laboratory have safety procedures, which include safety practices, for any work that involves hazardous materials. These safety procedures should be laboratory specific and communicated via lab specific trainings, Standard Operating Procedures, or Job Safety Analyses and properly documented.

STANDARD OPERATING PROCEDURES

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. While general guidance regarding laboratory work with chemicals is contained in this plan, PIs/Laboratory Supervisors are required to develop and implement laboratory-specific standard operating procedures (SOPs) for certain hazardous chemicals and PHS that are used in their laboratories. 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. 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 should be written by laboratory personnel who are most knowledgeable and involved with the experimental process. The Principal Investigator and 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 or PHS 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 substance is particularly hazardous, as a mixture of chemicals will generally be more toxic than its most toxic component.

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, PHS, or specialized practices, consideration must be given to whether additional consultation with safety professionals is warranted or required.

Resources for SOPs:

- EH&S SOP Template Library (http://sop.ehs.ucla.edu/)
- SOP Fact Sheet (https://ucla.app.box.com/ehs-sops)
- SOP Protocol Fact Sheet (https://ucla.app.box.com/ehs-sop-protocol)
- UCLA School of Medicine SOP Template Library with Sample Procedures (http://safety.healthsciences.ucla.edu/pages/sop)

PROTECTIVE APPAREL AND 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. Specific minimum requirements for PPE use for chemical operations are contained in UCLA Policy 905 (Appendix B).

The PPE policy 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 flammables. Please consult UCLA Policy 905 (Appendix B) for details.

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. The EH&S website provides a PPE Selection Guide (https://ucla.app.box.com/ehs-ppe-selection-guide) to assist in selecting the appropriate glove type for the type of potential hazard.

EH&S policy requires each laboratory to complete a "Laboratory Hazard Assessment Tool" (http://lsm.ehs.ucla.edu/) prior to beginning work and to provide annual updates thereafter. PPE can be selected based on this hazard assessment.

How to Use and Maintain PPE

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

For additional requirements and information on selection of PPE, see UCLA Policy 905 (Appendix B).

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. Non-heavily 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 must be informed of potentially harmful effects of exposure to hazardous chemicals and must be provided with information to protect themselves.

Respiratory Protection

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

- An accidental spill such as:
  - a chemical spill outside the fume hood
  - a spill of 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 fill out the Respiratory Hazard Assessment form, review it with his/her supervisor, and fax the completed form to the **EH&S Respirator Program Administrator at 310-825-7076**. EH&S 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

Tasks 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 UCLA's Respiratory Protection Program.

If EH&S recommends respirator use for a task, the employee must first enroll in the next available Respirator Training and Fit Testing offered through EH&S. These classes contain the three components required by Cal/OSHA: medical evaluation, training and fit testing. The class schedule is available on the EH&S website (https://worksafe.ucla.edu/). Employees must complete all components prior to starting work that requires respirator use.

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 by a nurse practitioner before the employee proceeds with the training. NOTE: This medical questionnaire is confidential. The employee will be provided additional information on how to contact the nurse practitioner 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 UCLA's Respiratory Protection Program and Cal/OSHA regulations (8 CCR 5144, http://www.dir.ca.gov/title8/5144.html)

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

Documentation of PPE issuance

All labs are required to document the issuance of appropriate PPE to their personnel. The Laboratory Hazard Assessment Tool (http://lsm.ehs.ucla.edu/)allows for this documentation. Labs are required to print the Laboratory Hazard Assessment Tool and have all lab workers sign the PPE verification page.

Laboratory Safety Equipment

New personnel must be instructed in the location of fire extinguishers, safety showers, and other safety equipment *before* they begin work in the laboratory. This training is considered part of the laboratory specific training that all staff members must attend. UCLA EH&S has released a suggested Site-Specific Orientation checklist (https://ucla.app.box.com/ehs-site-safety-checklist) for labs to use to complete this requirement.

Fire Extinguisher

All laboratories working with combustible or flammable chemicals must be outfitted with appropriate fire extinguishers. All extinguishers should be mounted on a wall in an area free of clutter or stored in a fire extinguisher cabinet. Research personnel should be familiar with the location, use and classification of the extinguishers in their laboratory.

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

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

Any time a fire extinguisher is used, no matter for how brief a period, the PI/Laboratory Supervisor, or most senior laboratory personnel present at the time of the incident, must immediately report the incident to the **EH&S Hotline at 310-825-9797**.

The EH&S website contains a *Fire Safety in the Laboratory* video, which provides information on fire extinguisher use. Visit the [EH&S Online Video page (https://www.ehs.ucla.edu/training/videos)](https://www.ehs.ucla.edu/training/videos) to view this video, and other safety videos.

Safety Showers and Eyewash Stations

All laboratories using hazardous chemicals must have immediate access to safety showers with eye wash stations. Access must be available in **10 seconds** or less for a potentially injured individual and access routes must be kept clear. Safety showers must have a minimum clearance of 16 inches from the centerline of the spray pattern in all directions at all times; this means that no objects should be stored or left within this distance of the safety shower. Sink based eyewash stations and drench hoses are not adequate to meet this requirement and can only be used to support an existing compliant system. Additionally, keg-type shower/eyewash systems are only acceptable as a temporary solution and are not intended to replace emergency safety showers/eyewash stations connected to the building's plumbing.

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

Safety shower/eyewash stations are tested by Facilities Management on a monthly basis. Any units which do not have a testing date within one month should be reported immediately to the **EH&S Hotline at 310-825-9797**. If an eyewash or safety shower needs repair, call Facilities Management Trouble Call at 310-825-9236 and give the operator the specific location of the defective equipment. Facilities Services Requests (FSRs) that have been generated as a result of a health and safety deficiency, such as this, must be flagged as "URGENT". A system has been implemented to expedite these FSRs.

Fire Doors

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

PRUDENT LABORATORY PRACTICES

It is prudent to minimize all chemical exposures. Few laboratory chemicals are without hazards, and general precautions for handling all laboratory chemicals should be adopted, in addition to specific guidelines for particular chemicals. Exposure should be minimized even for substances of no known significant hazard, and special precautions should be taken for work with substances that present special hazards. One should assume that any mixture will be more toxic than its most toxic component and that all substances of unknown toxicity are toxic.

Avoid inadvertent exposures to hazardous chemicals by developing and encouraging safe habits and thereby promoting a strong safety culture.

SAFE LABORATORY HABITS

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

Personal Protective Equipment:

- Follow UCLA Policy 905 (Appendix B).
- Do not enter the laboratory without wearing appropriate clothing, including closed-toe shoes and full length pants, or equivalent. The area of skin between the shoe and ankle should not be exposed.
- Ensure that appropriate PPE is worn by all persons, including visitors, where chemicals are stored or handled.
- Confine long hair and loose clothing.
- Utilize appropriate PPE while in the laboratory and while performing procedures that involve the use of hazardous chemicals or materials. These items may include laboratory coats, gloves, and safety glasses or goggles.
- Wear appropriate gloves when the potential for contact with toxic materials exists; inspect the gloves before each use, and replace them often.
- Remove laboratory coats or gloves immediately on significant contamination, as well as before leaving the laboratory.
- Do not wear laboratory coats or gloves outside of the laboratory area.
- Use appropriate respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls, inspecting the respirator before use. Use of respirators requires successful completion of the EH&S Respirator Training and Fit Test course. Visit https://www.ehs.ucla.edu/ep/ih/resp for course description and registration information.

- Use any other protective and emergency apparel and equipment as appropriate. Be aware of the locations of first aid kits and emergency eyewash and shower stations.

***Chemical Handling*:**

- Use only those chemicals for which the quality of the available ventilation system is appropriate.
- Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices.
- Properly label and store all chemicals.
- Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (Chapter 9).
- Do not allow release of toxic substances or fumes into cold or warm rooms, as these types of areas typically involve re-circulated atmospheres.
- Do not smell or taste chemicals.
- Never use mouth suction for pipetting or starting a siphon.
- Do not dispose of any hazardous chemicals through the sewer system. These substances might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow.
- 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. Information on minor chemical spill mitigation may also be referenced in Chapter 10 and Appendix F. For general guidance, the following situations should be addressed:
    - Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention.
    - Skin Contact: Promptly flush the affected area with water and remove any contaminated clothing. Seek medical attention.

Equipment Storage and Handling:

- Use equipment only for its designed purpose.
- Store laboratory glassware with care to avoid damage. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur.
- Use certified fume hoods, glove boxes, or other ventilation devices for operations which might result in release of toxic chemical vapors or dust. Preventing the escape of these types of materials into the working atmosphere is one of the best ways to prevent exposure.
- Keep hood closed when you are not working in the hood.

- Leave the fume hood "on" even when it is not in active use if toxic substances are in the fume hood or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off."
- Do not use damaged glassware or other equipment.
- Do not use uncertified fume hoods for hazardous chemical handling.
- Avoid storing materials in fume hoods which would obstruct proper air flow.

Laboratory Operations:

- Keep the work area clean and uncluttered.
- Seek information and advice about hazards, plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation.
- If unattended operations are unavoidable, and have been approved by the PI/Laboratory Supervisor, place an appropriate sign on the door, leave lights on, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water).
- Be alert to unsafe conditions and ensure that they are corrected when detected.
- Receive both general (Chapter 7) and lab specific trainings.
- Research staff and students should never work alone on procedures involving hazardous chemicals, biological agents, or other physical hazards.
- New PIs should consult UCLA EH&S fact sheets (https://ucla.box.com/ehs-lab-safety-orientationand https://ucla.box.com/ehs-setting-up-a-lab).
- If minors are in laboratories be sure to follow UC's Policy on Minors in Labs and Shops (https://ucla.box.com/ehs-uc-minors-labs-impacts).
- Do not engage in distracting behavior such as practical jokes in the laboratory. This type of conduct may confuse, startle, or distract another worker.

Food/Drink:

- No food or drink may be present or consumed in a laboratory or any other space in which hazardous materials are stored or handled.
- Do not smoke, chew gum, or apply cosmetics in areas where laboratory chemicals are present; wash hands before conducting these activities.
- Do not dispose of food/drink waste in laboratory trash containers.
- Do not store, handle, or consume food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations.
- Wash areas of exposed skin well before leaving the laboratory.

CHAPTER 4: CHEMICAL EXPOSURE ASSESSMENT

REGULATORY OVERVIEW

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

Cal/OSHA has listed established PELs, STELs and Ceiling exposures for chemical contaminants identified in CCR Title 8 Section 5155 (Airborne Contaminants) Table AC-1 (http://www.dir.ca.gov/Title8/ac1.pdf). 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 Safe 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 (http://oehha.ca.gov/prop65/prop65_list/files/P65single060614.pdf).

EXPOSURE ASSESSMENT OVERVIEW

All University employees require protection from exposure to hazardous chemicals above PELs, STELs and Ceiling concentrations. Cal/OSHA requires the person supervising, directing or evaluating the exposure assessment monitoring be competent in the practice of industrial hygiene. Thus, exposure assessment should be performed only by representatives of EH&S and not the PI/Laboratory Supervisor. General questions regarding exposure assessment or the Industrial Hygiene Program can be directed to indhyg@ehs.ucla.edu or 310-794-5080.

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

1. EH&S bases whether an exposure assessment is warranted by reviewing chemical inventories, reviewing Standard Operating Procedures (SOPs), types of engineering controls present, laboratory inspection results and/or reviewing the annual Laboratory Hazard Assessment Tool.; or
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 (such as transfer of a chemical through a double needle performed entirely in a fume hood) and the potential for exposure exists. The user should then inform his or her PI/Laboratory Supervisor, who will in turn contact the EH&S Industrial Hygiene Program, EH&S Radiation Safety Division, EH&S Injury Prevention Division, or the University's Occupational Health Facility (OHF). EH&S and OHF will then determine the best course of action in assessing employee exposure, including visual assessment, air monitoring, medical evaluation, examination, or medical surveillance.; or
3. A regulatory requirement exists to perform an initial and if warranted periodic monitoring.

In event of any serious injury or exposure, including chemical splash involving dermal or eye contact, immediately call 911 from a campus phone or 310-825-1491 from an off-campus or cell phone and obtain medical treatment immediately. Do not wait for an exposure assessment to be performed before seeking medical care.

EXPOSURE ASSESSMENT PROTOCOL – NOTIFICATION TO EMPLOYEES OR EMPLOYEE REPRESENTATIVES AND RIGHT TO OBSERVE MONITORING (SECTION 340.1)

The EH&S Industrial Hygiene Program conducts exposure assessments for members of the campus community. Employees have a right to observe testing, sampling, monitoring or measuring of employee exposure. They are also allowed access to their records and reports related to their 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. General protocol in conducting an exposure assessment may include any of the following:

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

If exposure monitoring determines an employee exposure to be over the action level (or the PEL) for a hazard for which OSHA has developed a specific standard (e.g., lead), the medical surveillance provisions of that standard shall be followed. It is the responsibility of the PI/Laboratory Supervisor to ensure that any necessary medical surveillance requirements are met. When necessary, EH&S will make recommendations regarding adjustments to engineering controls or administrative procedures to maintain exposure below any applicable PEL. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the Principal Investigator will provide, at no cost to the employee, the proper respiratory equipment and training. Respirators will be selected and used in accordance with the requirements of [CCR Title 8 Section 5144 (http://www.dir.ca.gov/Title8/5144.html)](http://www.dir.ca.gov/Title8/5144.html) and the University's Respiratory Protection Program.

In assessing exposure to hazardous chemicals for which Cal/OSHA has not published a PEL, STEL or Ceiling exposure, EH&S defers to the Threshold Limit Values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) or the Recommended Exposure Limits (RELs) established by the National Institute of Occupational Safety & Health (NIOSH). Please contact the EH&S Hotline at 310-825-9797 for more information regarding these chemicals.

NOTIFICATION

The Industrial Hygiene Program will promptly notify the employee and his/her PI/Laboratory Supervisor of the results in writing (within 15 working days or less when required by regulation) after receipt of the monitoring results. The Industrial Hygiene Program will establish and maintain an accurate record of any measurements taken to monitor exposures for each employee. Records, including monitoring provided by qualified vendors, will be managed in accordance with CCR Title 8 Section 3204 "Access to Employee Exposure and Medical Records" (http://www.dir.ca.gov/Title8/3204.html).

EXPOSURE ASSESSMENT USE TO DETERMINE AND IMPLEMENT CONTROLS

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

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

Particular attention shall be given to the selection of safety control measures for chemicals that are known to be extremely hazardous. Per Cal/OSHA CCR Title 8 Section 5141 "Control of Harmful Exposure to Employees" (http://www.dir.ca.gov/Title8/5141.html), the control of harmful exposures shall be prevented by implementation of control measures in the following order:

1. Engineering controls, whenever feasible;
2. Administrative controls whenever engineering controls are not feasible or do not achieve full compliance and administrative controls are practical; and
3. Personal protective equipment, including respiratory protection, during:
    a. the time period necessary to install or implement feasible engineering controls
    b. when engineering and administrative controls fail to achieve full compliance
    c. in emergencies

MEDICAL EVALUATION

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

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

All work-related medical evaluations and examinations will be performed under the direction of UCLA's Occupational Health Facility (OHF) by licensed physicians or staff under the direct supervision of a licensed physician. Evaluations and examinations will be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

Any laboratory employee who exhibits signs and symptoms of adverse health effects from work-related exposure to a hazardous chemical should report to OHF immediately for a medical evaluation.

Student workers who exhibit signs and symptoms of adverse health effects from work-related exposure to a hazardous chemical should report to the Arthur Ashe Student Health and Wellness Center.

Refer to your Department's Injury & Illness Prevention Program (IIPP) for procedures on how to obtain medical evaluation under the above-listed circumstances.

INFORMATION TO PROVIDE TO THE CLINICIAN

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

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

6. A copy of the Safety Data Sheet (SDS) of the hazardous chemical in question;
7. History of exposure including previous employment and non-occupational (recreational) hobbies; and
8. Any additional information helpful to OHF in assessing or treating an exposure or injury such as a biological component of exposure or existence of an antitoxin.

PHYSICIAN'S WRITTEN OPINION

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

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

Confidentiality & Individual's Access to Personal Medical Records

All patient medical information is protected by California and federal law and is considered strictly confidential. OHF is prohibited from disclosing any patient medical information that is not directly related to the work-related exposure under evaluation and will not reveal any diagnosis unrelated to the work-related exposure. Any patient information disclosed by OHF 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 OHF 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. OHF 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. OHF will provide an employee with a copy of his/her medical records upon written request.

Medical Surveillance

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

OHF 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
- Formaldehyde
- Lead
- Methylene Chloride
- Noise (Hearing Conservation Program)
- Radioactive Chemicals (Bioassay Program)
- Respirator Use (Respirator Protection Program)
- Other Particularly Hazardous Substances

Individuals with questions regarding work-related medical surveillance are encouraged to contact **OHF at 310-825-6771** or the **EH&S Hotline at 310-825-9797** for more information.

CHAPTER 5: CHEMICAL INVENTORY AND CHEMICAL HAZARD COMMUNICATION

REGULATORY REQUIREMENTS

UCLA has an established Hazard Communication Program that complies with 8 CCR 5194 the Cal/OSHA Hazard Communication Standard. The purpose of UCLA's Hazard Communication Program is to ensure that all employees and, upon request, their personal physicians, have the right to receive information regarding the hazardous substances to which they may have been exposed at work. UCLA is responsible for providing information about the hazardous substances in our workplace, the associated hazards, and the control of these hazards, through a comprehensive hazard communication program that is summarized briefly below.

The requirements of the Hazard Communication Program apply to laboratory environments at UCLA due to the potential for large scale experiments and for activities that may occur outside of areas where engineering controls are available. Proper hazard communication involves the active participation of the PI/Laboratory Supervisor, the EH&S Chemical Safety Officer, and the Laboratory/Facility Safety Coordinator, who are each responsible for providing consultation and safety information to employees working with hazardous chemicals.

CHEMICAL INVENTORIES

Each laboratory group is required to maintain a current chemical inventory that lists the chemicals and compressed gases used and stored in the labs and the quantity of these chemicals.

Chemical inventories are used to ensure compliance with storage limits and other regulations and can be used in an emergency to identify potential hazards for emergency response operations.

The chemical inventory list should be reviewed prior to ordering new chemicals and only the minimum quantities of chemicals necessary for the research should be purchased. As new chemicals are added to the inventory, each laboratory group must confirm that they have access to the Safety Data Sheets (SDS) for those chemicals. Where practical, each chemical should be dated so that expired chemicals can be easily identified for disposal. Inventory the materials in your laboratory frequently (at least annually) to avoid overcrowding with materials that are no longer useful and note the items that should be replaced, have deteriorated, or show container deterioration. Unneeded items should be returned to the storeroom/stockroom and compromised items should be discarded as chemical waste.

Indications for disposal include:

- Cloudiness in liquids
- Color change
- Evidence of liquids in solids, or solids in liquids
- "Puddling" of material around outside of containers
- Pressure build-up within containers
- Obvious deterioration of containers

Access to hazardous chemicals, including toxic and corrosive substances, should be restricted at all times. These materials must be stored in laboratories or storerooms that are kept locked when laboratory personnel are not present. Locked storage cabinets or other precautions are always recommended, and in some cases may be required in the case of unusually toxic or hazardous chemicals. Unusually toxic chemicals may include those that are associated with very low immediately dangerous to life or health (IDLH) conditions. For guidance on locked storage requirements, please contact the EH&S Hotline at 310-825-9797. On termination or transfer of laboratory personnel, all related hazardous materials should be properly disposed of, or transferred to the laboratory supervisor or a designee.

To facilitate improved inventory management and reporting, UCLA is implementing a Chemical Inventory System (CIS). The CIS will allow UCLA to more easily comply with both long standing and new regulation requiring chemical inventory maintenance and reporting. Cal/OSHA Title 8 Section 5194 (e) (1) (https://www.dir.ca.gov/title8/5194.html) requires that employers develop and maintain a list of the hazardous chemicals known to be present in the workplace. This is a long standing regulatory requirement and is an important component of our lab safety inspections. New regulation in the form of Assembly Bill 2286 (http://www.calepa.ca.gov/CUPA/Documents/eReporting/AB2286.pdf) mandates the development of the California Environmental Reporting System (CERS, http://cers.calepa.ca.gov/) and requires all regulated businesses to use the Internet to electronically submit chemical inventories.

In order to facilitate compliance with the new electronic reporting requirement, each lab group is required to upload an up-to-date chemical inventory to the CIS using our Chemical Inventory Template (https://ucla.box.com/ehs-chem-inventory-template).This template (.xls) has been developed to address the regulatory requirements of CERS. Please see our Chemical Inventory Template Instructions (https://ucla.box.com/ehs-chem-invent-instructions) for details. All UCLA PIs can log in to the CIS using their UCLA Logon credentials at http://ehs.ucop.edu/cis. Once logged in, PIs can designate “Authorized Personnel” to manage their lab’s inventory. Additional information is available on the Chemical Inventory

Program(https://www.ehs.ucla.edu/research/lab/chem/cip) webpage. This includes Chemical Inventory Guidelines(https://ucla.box.com/ehs-chem-inventory-guidelines) that describe what chemicals must be included in the inventory and what may be excluded.

Questions and comments regarding the CIS and Chemical Inventory Program should be directed to chemicalinventory@ehs.ucla.edu.

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.

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

1. "The Hazardous Substance List (http://www.dir.ca.gov/title8/339.html)", commonly known as the Directors List of Hazardous Substances, 8 CCR 339 ;
2. "Toxic and Hazardous Substances, Air Contaminants (http://www.dir.ca.gov/title8/5155.html)", 8 CCR, Section 5155 ;
3. "Threshold Limit Values for Chemical Substances in the Work Environment (http://www.modares.ac.ir/file/022009CSTLVs_Introduction.pdf?p=L3VwbG9hZHMvVEFSQklBVC9UQkxfUEFHRV9GSUxFLzAyLTIwMDktQ1MtVExWc19JbnRyb2R1Y3Rpb24ucGRmLjI4OTI4OF9QQVRI&n=MDItMjAwOS1DUy1UTFZzX0ludHJvZHVjdGlvbi5wZGY)", ACGIH, 2009;
4. "Thirteenth Annual Report on Carcinogens(http://ntp.niehs.nih.gov/pubhealth/roc/roc13/index.html)", NTP, 1991;
5. "Monographs (http://www.iarc.fr/en/publications/list/monographs)", IARC, WHO
6. SDSs for reproductive toxins and cancer causing substances (Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)); and
7. "Chemicals Known to the State to Cause Cancer or Reproductive Toxicity" (Proposition 65, http://oehha.ca.gov/prop65/prop65_list/newlist.html), 22 CCR 12000.

SAFETY DATA SHEETS (SDS)

An SDS must be available for each hazardous substance in a laboratory's chemical inventory. SDSs are available from Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip). PIs/Laboratory Supervisors are responsible for keeping SDSs current and making them available to all laboratory employees throughout the work day. SDSs must be in a central location that can be accessed immediately in the event of an emergency. Electronic copies may be kept in a file on a group drive, or hard copies maintained in a central location in the laboratory.

New chemical substances synthesized or produced in a laboratory, and used or shared outside of a laboratory suite, require the preparation of an SDS for each synthesized substance. The UC-system wide SDS library has the capability of developing new SDSs based on the known chemical and physical properties of that substance. Contact the **EH&S Hotline at 310-825-9797** for more information on preparing new SDSs.

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

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

LABELS AND OTHER FORMS OF WARNING

Labeling requirements for all hazardous substances are summarized as follows:

- All containers of hazardous materials must be labeled with the identity of the hazardous substance

- The label must contain all applicable hazard warning statements
- The name and address of the chemical manufacturer or other responsible party must be present
- Manufacturer's product labels must remain on all containers, and must not be defaced in any way. Appropriate hazard warning statements must be present, if not that information must be added
- Labels must be legible, in English, and prominently displayed
- Symbols and/or other languages are required for non-English speaking employees
- Secondary containers (such as spray bottles) must be labeled with the identity of the substance and appropriate hazard warnings
- New synthesized compounds must be labeled with the appropriate hazard warnings based on the knowledge of the chemical and physical properties of that substance.

CHEMICAL LABELING

Every chemical found in the laboratory must be properly labeled. Most chemicals come with a manufacturer's label that contains the necessary information, so care should be taken to not damage or remove these labels. Each chemical bottle, including diluted chemical solutions, must be labeled with its contents and the hazards associated with this chemical. It is recommended that each bottle also be dated when received and when opened to assist in determining which chemicals are expired and require disposal. When new chemicals and compounds are generated by laboratory operations, these new chemical bottles must be labeled with the name, date, and hazard information; the generator or other party responsible for this chemical should be named on the container so that they may be contacted if questions arise about the container's contents.

Peroxide forming chemicals (e.g., ethers) (Appendix F) must be labeled with a date on receipt and on first opening the bottle. These chemicals are only allowed a one year shelf life and should be disposed of as hazardous waste in one year. These chemicals can degrade to form shock sensitive, highly reactive compounds and should be stored and labeled very carefully.

Figure 5.1 – Printable Safety

Particularly Hazardous Substances (see Chapter 2) require additional labeling. Printable safety labels (see Figure 5.1) are available on the UCLA Chemistry website (http://www.chemistry.ucla.edu/print-safety-labels)and EH&S website (https://www.ehs.ucla.edu/research/ghs-safety-labels) which identify the specific hazard associated with each of these chemicals (carcinogen, reproductive toxicant, acute 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.

GLOBAL HARMONIZATION SYSTEM (HAZARD COMMUNICATION STANDARD PICTOGRAMS)

Health Hazard  • Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	**Flame**  • Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides	**Exclamation Mark**  • Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non-Mandatory)
Gas Cylinder  • Gases Under Pressure	**Corrosion**  • Skin Corrosion/Burns • Eye Damage • Corrosive to Metals	**Exploding Bomb**  • Explosives • Self-Reactives • Organic Peroxides
Flame Over Circle  • Oxidizers	**Environment** (Non-Mandatory)  • Aquatic Toxicity	**Skull and Crossbones**  • Acute Toxicity (fatal or toxic)

EMPLOYEE INFORMATION AND TRAINING

Employee training on specific workplace hazards must be provided at the time of initial assignment, whenever a new hazard is introduced into the workplace, and whenever employees may be exposed to hazards in other work areas.

General Hazard Communication Training is available online through the UCLA Worksafe (http://worksafe.ucla.edu). Additional employee training is required whenever a new hazard is introduced into the work environment, and must be provided within 30 days of receiving the SDS or other safety information. All training must be in the appropriate language, educational level, and vocabulary for laboratory personnel. Employees must be given the opportunity to ask questions.

Additional resources are available online through the Bruin Safety training module (http://training.ucla.edu/ehs/). Bruin Safety training is not a substitution for Laboratory Safety Fundamentals Concepts (see Chapter 7).

LABORATORY HAZARD ASSESSMENT TOOL

The Laboratory Hazard Assessment Tool (http://lsm.ehs.ucla.edu/) (LHAT) was developed to broadly identify activities involving chemical and other types of hazards and is an effective method of hazard communication. The 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 helps identify the proper PPE that should be used by laboratory personnel to protect themselves against these hazards. Once the required PPE is identified, the laboratory is required to conduct and document training for laboratory personnel on the use of PPE.

OTHER RESOURCES

1. "Occupational Exposure to Hazardous Chemicals in Laboratories." California Code of Regulations (CCR) Title 8, Section 5191(https://www.dir.ca.gov/title8/5191.html);
2. Standard Operating Procedures (SOPs) for handling toxic chemicals (Appendix F);
3. General information on the signs and symptoms associated with exposure to hazardous substances used in the laboratory or facility
   - Identity labels, showing contents of containers (including waste receptacles) and associated hazards;
   - Label hazardous waste containers. See the EH&S website for information about the WASTe (https:/www.ehs.ucla.edu/hazwaste/management/labeling)
   - Warnings at areas or equipment where special or unusual hazards exist (e.g., particularly hazardous substances);
4. Procedures to follow in case of an emergency; including the posting of the "In Case of Serious Injury at Work" (https://ucla.box.com/ehs-serious-injury-poster)
   - Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers; and
   - Location signs for safety showers, eyewash stations, other safety and first aid equipment, exits and areas where food and beverage consumption and storage are permitted.

CHAPTER 6: STORAGE, SECURITY, AND TRANSPORT

CHEMICAL STORAGE & SEGREGATION

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

Storage guidelines are included for materials that are flammable, oxidizers, corrosive, 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. Each laboratory is required to conduct lab specific training on the hazardous chemicals and to effectively communicate the hazards stored in a laboratory. Table 6.1 lists chemical safety storage priorities.

Table 6.1 – Chemical Safety Storage Priorities

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

1. **Flammability.** When establishing a storage scheme, the number one consideration should be the flammability characteristics of the material. If the material is flammable, a flammable cabinet or a refrigerator rated for flammable storage is the best practice. The maximum amount of flammables allowed outside a flammable storage cabinet, safety can, or approved refrigerator/freezer is 10 gallons.

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 exacerbate the situation, isolate the water reactive material from possible contact with water.

3. **Corrosivity.** Next look at the corrosivity of the material, and store accordingly.

GENERAL RECOMMENDATIONS FOR SAFE STORAGE OF CHEMICALS

Each chemical in the laboratory must 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. Figure 6.1 depicts improper fume hood storage. Chemicals should not be routinely stored on bench tops or stored on the floor.

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

Figure 6.1 – Improper Fume Hood Storage

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 eliminate the possibility of mixing and of adverse reactions. All stored containers and research samples must be appropriately labeled and tightly capped to prevent vapor interactions and to alleviate nuisance odors. Storing chemicals in flasks with cork, rubber or glass stoppers should be avoided because of the potential for leakage.

Laboratory refrigerators and freezers must be labeled appropriately with "No Food/Drink" and must **never** be used for the storage of consumables. Freezers should be defrosted periodically so that chemicals do not become trapped in ice formations.

FLAMMABLE AND COMBUSTIBLE LIQUIDS

Large quantities of flammable or combustible materials should not be stored in the laboratory. The maximum total quantity of flammable and combustible liquids must not exceed **60 gallons** within 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** with no container being larger than **1 gallon**. Only the amounts needed for the current procedure should be kept on bench tops and the remainder should be kept in flammable storage cabinets, refrigerators/freezers that are 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. 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 EH&S Fire Safety in the Laboratory video provides fire safety information and can be viewed online at: https://www.ehs.ucla.edu/training/videos.

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.

The EH&S *Pyrophoric Liquid Safety* video provides information about the safe handling of pyrophoric chemicals and can be viewed online at: *https://www.ehs.ucla.edu/training/videos*.

OXIDIZERS

Oxidizers (e.g., hydrogen peroxide, potassium dichromate, sodium nitrate) 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, such as zinc, alkaline metals, and formic acid.

PEROXIDE FORMING CHEMICALS (PFC)

Peroxide forming chemicals (e.g. diethyl ether, cyclohexene, tetrahydrofuran) should be stored in airtight containers in a dark, cool, and dry place and must be segregated from other classes of chemicals that could create a serious hazard to life or property should an accident occur (e.g., acids, bases, oxidizers). All containers with PFCs should be labeled with the date received and the date opened. This information, along with the chemical identity should face forward to minimize container handling during inspection. Minimize the quantity of peroxide forming chemicals stored in the laboratory and dispose of peroxide forming chemicals before peroxide formation. Refer to Appendix F for specific guidelines and/or contact EH&S with questions. 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.

If old containers of peroxide forming chemicals are discovered in the laboratory, (the container is more than two years past its expiration date, the date of the container is unknown, or you are not comfortable handling the container), **do not handle the container**. If crystallization is present in or on the exterior of a container, **do not handle the container**. Secure it and contact the **EH&S Hotline at 310-825-9797** for pick-up and disposal.

Disposal of expired peroxide-forming chemicals may incur a charge of $100 (at minimum) per container. When disposing of these chemicals, the laboratory must complete a recharge order request or P39 form. The P39 form is available at: https://ucla.box.com/ehs-recharge-order-request.

CORROSIVES

Store corrosive chemicals (i.e., acids, bases) below eye level and in secondary containers that are 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).

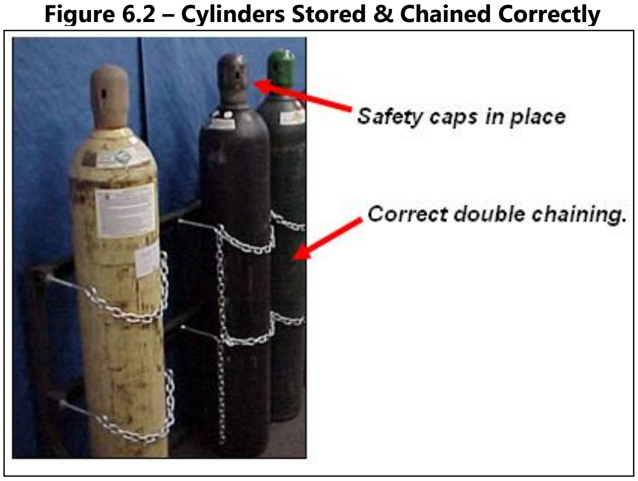
Specific types of acids require additional segregation. Mineral acids must be kept away from organic acids and oxidizing acids must be segregated from flammable and combustible substances. Perchloric acid should be stored by itself, away from other chemicals. Picric Acid is reactive with metals or metal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

SPECIAL STORAGE REQUIREMENTS

Compressed Gas Cylinders

Compressed gas cylinders must be stored with the safety cap in place when not in use. Cylinders must be stored either chained to the wall or chained in a cylinder storage rack. The cylinders must be restrained by two chains; one chain must be placed at one third of the cylinder height from the top of the cylinder, and the other placed at one third of the cylinder height from the bottom of the cylinder (see Figure 6.2). For wall storage, no more than three cylinders may be chained together in the laboratory. Bolted "clam shells" may be used in instances where gas cylinders must be stored or used away from the wall. Store liquefied fuel-gas cylinders securely in the upright position. **Cylinders containing certain gases are prohibited from being stored in a horizontal position, including those that contain a water volume of more than 5 liters.** Do not expose cylinders to excessive dampness, corrosive chemicals or fumes.

Figure 6.2 – Cylinders Stored & Chained Correctly



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

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 should 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. Refer to the UCLA Compressed Gas Cylinder Storage and Handling policy(http://www.chemistry.ucla.edu/sites/default/files/safety/sop/SOP_Compressed_Gas_Cylinders.pdf) for further details.

Liquid Nitrogen

Because liquid nitrogen 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 liquid nitrogen in a laboratory. The primary risk to laboratory personnel from liquid nitrogen is skin or eye thermal damage caused by contact with the material. In addition, nitrogen expands 696:1 when changing from a cryogenic liquid to a room temperature gas. The gases usually are not toxic, but if too much oxygen is displaced, asphyxiation is a possibility. A physical hazard also exists for cyrovials stored in the liquid phase, which may explode when warmed. Always use appropriate thermally insulated gloves when handling liquid nitrogen. Face shields may be needed in cases where splashing can occur, or when cyrovials are being removed and warmed.

Chemical Segregation

Table 6.2 contains information regarding the general hazard class segregation that should be followed. These chemicals require separation by at least an appropriate secondary container, and in some cases should be located in different cabinets or locations completely. Such circumstance includes flammable and oxidizing gases.

Table 6.2 – Hazard class Segregation

Hazard Class	Keep out of contact with:
Flammables	Oxidizers
Acids	Bases
Organic Acids	Inorganic Acids
Water Reactive Chemicals	Water and Aqueous Solutions

Chemical hazardous waste containing these hazard classes should also be segregated. Please see Chapter 9 for additional information on hazardous waste storage and segregation.

Table 6.3 contains a list of incompatible chemicals. The chemicals, listed in the left column, should not be used with chemicals listed in the right column, except under specially controlled conditions. Chemicals in the left column should not be stored in the immediate area with chemicals in the right column. Incompatible chemicals should always be handled, stored or packed so that they cannot accidentally come into contact with one another.

This list is representative of chemical incompatibilities and is not complete, nor are all incompatibilities shown. Please see manufacturer's SDS for additional information.

Table 6.3 – Incompatible Chemicals

Chemical	Keep Out of Contact with:
Alkaline metals, such as powdered aluminum, magnesium, sodium, potassium, etc.	Carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide and water
Acetic Acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides and permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver and mercury
Ammonia	Mercury, chlorine, calcium hypochlorite, iodine, bromine and hydrofluoric acid
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Carbon, activated	Calcium hypochlorite
Copper	Acetylene and hydrogen peroxide
Chromic acid	Acetic acid, naphthalene, camphor, glycerin, turpentine, alcohol and flammable liquids
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane, hydrogen, sodium carbide, turpentine, benzene and finely divided metals
Cyanides	Acids - organic or inorganic
Hydrogen peroxide	Copper, chromium, iron, most metals, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids and combustible materials
Hydrogen sulfide	Fuming nitric acid and oxidizing gases
Hydrocarbons (butane, propane, benzene, gasoline, turpentine etc.)	Fluorine, chlorine, bromine, chromic acid and sodium peroxide
Iodine	Acetylene, ammonia and hydrogen
Nitric acid	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass and any heavy metals
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, ether, oils and grease
Phosphorous	Oxidizing agents, oxygen, strong bases
Potassium chlorate	Sulfuric and other acids
Potassium permanganate	Glycerin, ethylene glycol, benzaldehyde and sulfuric acid
Sodium	Carbon tetrachloride, carbon dioxide and water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate and furfural
Sulfuric Acid	Potassium chlorate, potassium perchlorate and potassium permanganate

Special Segregation of Incompatible Chemicals

In addition to the segregation noted in Table 6.3, dangerously incompatible substances, even in small quantities, should not be stored next to each other on shelves or in such a position that accidental rupture of containers may allow mixing.

Table 6.4 contains examples of dangerously incompatible substances. Table 6.5 contains examples of incompatible oxidizing agents and reducing agents.

Table 6.4 – Dangerously Incompatible Substances

Chemical	Keep out of contact with:
Chlorine	Acetylene
Chromic acid	Ethyl alcohol
Oxygen (compressed, liquefied)	Propane
Sodium	Chloroform and aqueous solutions
Nitrocellulose (wet, dry)	Phosphorous
Potassium permanganate	Sulfuric acid
Perchloric acid	Acetic acid
Sodium chlorate	Sulfur in bulk

Table 6.5 – Incompatible Oxidizing Agents and Reducing Agents

Oxidizing Agents	Reducing Agents
Chlorates	Ammonia
Chromates	Carbon
Dichromates	Metals
Chromium trioxide	Metal hydrides
Halogens	Organic Compounds
Halogenating agents	Phosphorus
Hydrogen peroxide	Silicon
Nitric acid	Sulfur
Nitrates	
Perchlorates	
Peroxides	
Permanganates	
Persulfates	

LABORATORY SECURITY

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 (http://www.deadiversion.usdoj.gov/schedules), Federal Bureau of Investigations (http://www.fbi.gov/about-us/investigate/terrorism/wmd),and Department of

Homeland Security (http://www.dhs.gov/xlibrary/assets/chemsec_appendixa-chemicalofinterestlist.pdf).

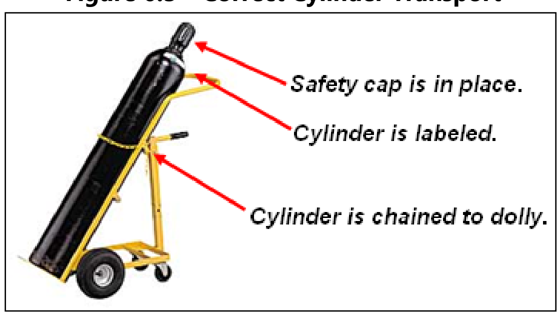
It is each laboratory's responsibility to prevent and report any theft of chemicals from their laboratory. Laboratories are encouraged to conduct a Security Value Assessment (SVA). Aspects that should be covered in a SVA include:

- Existing threats, based on the history of the institution (e.g., theft of laboratory materials, sabotage, data security breaches, protests);
- The attractiveness of the institution as a target, and the potential impact of an incident;
- Chemicals, biological agents, radioactive materials, or other laboratory equipment or materials with dual-use potential
- Sensitive data or computerized systems;
- Animal care facilities;
- Infrastructure vulnerabilities (e.g., accessible power lines, poor lighting);
- Security systems in place (e.g., access control, cameras, intrusion detection);
- Access controls for laboratory personnel (e.g., background checks, authorization procedures, badges, key controls, escorted access);
- Institutional procedures and culture (e.g., tailgating, open laboratories, no questioning of visitors);
- Security plans in place; and
- 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 UC Police (310-825-1491) and the UCLA EH&S hotline (310-825-9797).

ON-CAMPUS DISTRIBUTION OF HAZARDOUS CHEMICALS

Figure 6.3 – Correct Cylinder Transport



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. Refer to UCLA's Chemistry and Biochemistry Department for information on the "Procedures for Transporting Chemicals" policy (http://www.chemistry.ucla.edu/sites/default/files/safety/sop/Procedures_for_Transporting_Chemicals.pdf).

OFF-CAMPUS DISTRIBUTION OF HAZARDOUS CHEMICALS

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

Individuals who wish to ship or transport hazardous chemicals or compressed gases off-campus, even when using UCLA or personal vehicles, must contact EH&S at *laboratorysafety@ehs.ucla.edu* or the **EH&S Hotline at 310-825-9797** for assistance.

CHAPTER 7: TRAINING AND TRAINING MATRIX

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.

UCLA Worksafe (www.worksafe.ucla.edu) is a learning management system that will allow personnel to:

- Register for classroom training
- Complete online training & assessment
- Access and print training history reports
- View and print certificates of completion

The EH&S Training and Outreach Program provides both classroom and online training to help meet this requirement and can be contacted at training@ehs.ucla.edu.

TYPES OF TRAINING

All laboratory personnel must complete general safety training before:

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

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

GENERAL LABORATORY SAFETY TRAINING

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

- Review of laboratory rules and regulations, including the Chemical Hygiene Plan
- Recognition of laboratory hazards
- Use of engineering controls, administrative controls and personal protective equipment to mitigate hazards
- Exposure limits for hazardous chemicals

- Signs and symptoms associated with exposures to hazardous chemicals
- Chemical exposure monitoring
- Review of reference materials (e.g., SDS) on hazards, handling, storage and disposal of hazardous chemicals
- Procedures for disposing of hazardous chemical waste
- Fire safety and emergency procedures
- Information required by CCR Title 8 Section 3204 (https://www.dir.ca.gov/title8/3204.html) regarding access to employee exposure and medical records (annually required)

All employees must take one of the following basic laboratory classes provided by EH&S as appropriate for their employment status:

- **Laboratory Safety Fundamental Concepts** – for anyone working in a laboratory
- **Laboratory Safety for Principal Investigators and Laboratory Supervisors** – for PIs/Laboratory Supervisors responsible for implementing a laboratory safety plan

Additionally, all personnel are required to complete annual basic laboratory safety re-training. Personnel who have previously completed in-class training have the option to complete Online Refresher training instead. The training requirement is based on the calendar year. The Online Refresher can be viewed at http://training.ehs.ucla.edu. General laboratory safety training requirements are summarized on the EH&S Safety Training Matrix for Laboratory Personnel. Additional information can be obtained on the EH&S website (www.ehs.ucla.edu) and UCLA Worksafe (www.worksafe.ucla.edu).

LABORATORY-SPECIFIC TRAINING

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

- Location and use of the Chemical Hygiene Plan, IIPP, SDS(s) and other regulatory information
- Review of IIPP and Emergency Management Plan, including location of emergency equipment and exit routes
- Specialized equipment
- Standard Operating Procedures (SOPs)
- Specialized procedures and protocols
- Particularly Hazardous Substances including physical and health hazards, potential exposure, medical surveillance, and emergency procedures

- Many of these topics are covered in the site specific orientation checklist (https://ucla.box.com/ehs-site-safety-checklist). It is a University of California policy that each person working in a laboratory or technical area receives a one-time site specific orientation.
- Lab-specific training is recommended to be provided on a regular basis to promote a strong safety culture.

DOCUMENTATION OF TRAINING

Accurate recordkeeping is a critical component of health and safety training. Per OSHA regulations, departments or laboratories are responsible for documenting health and safety training, including safety meetings, one-on-one training, in-class and online trainings. Electronic copies are encouraged, however if hard copies are maintained documentation should be located in the laboratory safety manual. For lab specific trainings please include a sign in sheet with sufficient details such as date, topics discussed, and who lead the training. Additional information on recordkeeping can be found in Chapter 8: Inspections and Compliance.

EH&S provides recordkeeping resources. See the EH&S website (https://www.ehs.ucla.edu/research/lab/documents) for templates, including a Training History – Individual Employee template (https://ucla.app.box.com/ehs-training-history-ee), a Training Roster – Site-specific Training template (https://ucla.app.box.com/ehs-training-roster-group), and a Site Specific Orientation Checklist (https://ucla.app.box.com/ehs-site-safety-checklist).

Training histories for EH&S taught trainings for all laboratory employees are available to PIs/Laboratory Supervisors through the Training Tab located in the Lab Hazard Assessment Tool (LHAT). Any questions about the employee training records available here can be directed to RsrchTrain@ehs.ucla.edu. The training records available through the LHAT can serve as an official record of laboratory safety training conducted by EH&S.

RESOURCES

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

- Bruin Safety Training online training modules (www.training.ucla.edu/ehs)
  - Chemical Fume Hood
  - Cryogenic Nitrogen Safety
  - Fire Diamond
  - Fire Safety

    - Personal Protective Equipment
    - Working Safely with Formaldehyde

- Worksafe online training modules (www.worksafe.ucla.edu)
    - Hazard Communication

- EH&S Site online training modules (http://training.ehs.ucla.edu/)
    - Laboratory Safety Online Refresher Training

- Fact Sheets (https://www.ehs.ucla.edu/training/fact-sheets)
    - Compressed Gas Cylinders
    - Ethidium Bromide
    - Formaldehyde Use
    - Hazardous Waste Minimization
    - Laboratory Safety Orientation
    - Online Tag Program

- Online Safety Videos (https://www.ehs.ucla.edu/training/videos)
    - Pyrophoric Liquids Safety
    - Pipette Safety & Ergonomics
    - Hazardous Waste Management Safety
    - Fire Safety in the Laboratory
    - DVD Lending Library
        - Accident Prevention and Investigation
        - Air Quality Control
        - Chemical Hygiene/Laboratory Safety
        - Hazard Communication and General Safety
        - Respiratory Protection
        - Waste Management

EH&S provides additional assistance in planning laboratory-specific training upon request **(310-794-5328)**, laboratorysafety@ehs.ucla.edu).

UCLA ENVIRONMENT, HEALTH & SAFETY

Safety Training Matrix

For Laboratory Personnel

501 Westwood Plaza, 4th Fl • Los Angeles, CA 90095 • Ph: 310-825-5689 • Fx: 310-825-7076 • www.ehs.ucla.edu

What? This document outlines the minimum medical & training requirements for personnel working in a research setting. Answer the questions below to determine which requirements apply to you. If you answer "Yes," the corresponding requirements apply. (It is recommended that you complete the requirements in the numeric order listed below.

Who? Principal Investigators (PI), Lab Supervisors (LS), research personnel, graduate students & undergraduate students in research laboratories as well as general staff working in laboratories and animal housing facilities.

Are you UCLA faculty, staff or a student who…		Complete this Medical or Training Requirement (See Key Below)																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Animal Research Safety**	will handle animal carcasses, animal tissue or will have access to a vivarium?	◆																							
	will have direct contact with live vertebrate animals?	◆	◆																						
	is a PI, Faculty Sponsor or personnel listed on an ARC Protocol (even if you don't handle animals)?		◆																						
Laboratory Safety	is a PI or Laboratory Supervisor? *			◆		◆	◆																		
	will use chemicals or work in a wet lab? (excluding PI's or LS's) *				◆	◆	◆																		
	will use a respirator? *			◆	◆			◆																	
	will use pyrophorics, explosives or large quantities of flammables? *			◆	◆				◆																
Shop Safety	will use shop equipment?						◆			◆															
Biosafety ***	will work with human materials (e.g. blood, specimens, tissue or cells)? *			◆	◆						◆		◆												
	will use biohazardous materials? *			◆	◆							◆	◆	◆											
	will work in a Biosafety Level 2+ (BSL2+) lab?			◆	◆							◆	◆	◆	◆										
	will ship biological materials? *												◆			◆									
Radiation Safety	will handle radioactive materials? *			◆	◆												◆								
	will work with lasers?																	◆							
	will work with X-Ray equipment?																		◆						
DLAM Safety **	will work with mice?	◆																		◆					
	will work with rats?	◆																			◆				
	will work with a species other than mice or rats?	◆																				◆			
	will perform a survival surgery procedure or a procedure requiring aseptic technique?	◆																					◆		
	will enter or have access to an animal barrier facility?	◆																						◆	
	will enter or have access to an animal biocontainment facility?	◆											◆												◆

* Principal Investigators & Lab Supervisors complete "3" in lieu of "4" ** Check your ARC Protocol for further details *** Check your IBC Protocol for further details

Key	Requirements	Frequency	Contact	Key	Requirements	Frequency	Contact
1	Medical History Questionnaire (MHQ) *ONLINE*	Annual	OHF	13	Biosafety Level 2 A,B,C's (BSL2)	3 Years	EHS
2	Collaborative Institutional Training Initiative (CITI) *ONLINE*	3 Years	ARC	14	Biosafety Level 2 w/ Biosafety Level 3 practices (BSL2+)	3 Years	EHS
3	Lab Safety for PI's & LS's (initial) or Lab Safety Online Refresher (subsequent)	Annual	EHS	15	Shipping Biological Materials (SBM) - *ONLINE+$95 FEE*	2 Years	EHS
4	Lab Safety Fundamental Concepts (initial) or Lab Safety Online Refresher (subsequent)	Annual	EHS	16	New Radiation Worker Qualification (NRWQ)	Annual	EHS
5	Lab-Specific Safety Training – required for PI/LS and workers in wet labs	Annual[1]	EHS	17	Laser Safety	2 Years	EHS
6	Lab Site Safety Orientation	Once	EHS	18	X-Ray Diffraction Safety	Once	EHS
7	Respirator Training & Fit Test (Medical Clearance Required)	Annual	EHS	19	Working with Mice in Research Settings - *ONLINE+WET LAB*	Once	DLAM
8	Hands-On Fire Extinguisher Training	Once	EHS	20	Working with Rats in Research Settings - *ONLINE+WET LAB*	Once	DLAM
9	Shop Safety Training	Annual	EHS	21	Species Specific Training - *CLASS+WET LAB*	Once	DLAM
10	Bloodborne Pathogens (BBP)	Annual	EHS	22	Aseptic Surgical Technic - *ONLINE+WET LAB*	Once	DLAM
11	Biological Safety Cabinet (BSC)	3 Years	EHS	23	Working in a Barrier Facility - *ONLINE+WALKTHROUGH*	Once	DLAM
12	Medical Waste Management (MWM)	3 Years	EHS	24	Working in a Biocontainment Facility - *ONLINE+WALKTHROUGH*	Once	DLAM

[1]At least once a year or as needed as hazards in the laboratory change.

CHAPTER 8: INSPECTIONS AND COMPLIANCE

CHEMICAL SAFETY INSPECTIONS

EH&S has a comprehensive chemical safety compliance 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 UCLA's commitment to protecting the health and safety of the campus community.

As part of this chemical safety program, EH&S conducts annual inspections of laboratories and other facilities with hazardous chemicals to ensure the laboratory is operating in a safe manner and to ensure compliance with all federal, state and university safety requirements. The primary goal of inspection is to identify both existing and potential accident-causing hazards, actions, faulty operations and procedures that can be corrected **before** an accident occurs. UCLA Policy 811 (http://www.adminpolicies.ucla.edu/pdf/811.pdf) explicitly authorizes EH&S to order the cessation of any activity that is "Immediately Dangerous to Life and Health" (IDLH) until that hazardous condition or activity is abated.

The chemical safety inspection is comprehensive in nature and looks into all key aspects of working with hazardous chemicals. While inspections 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. Please see Appendix D: Laboratory Inspection Checklist. Specific inspection compliance categories include:

- Documentation and Training;
- Hazard Communication (including review of SOPs);
- Emergency and Safety Information;
- Fire Safety;
- General Safety;
- Use of personal protective equipment (PPE);
- Housekeeping;
- Chemical Storage;
- Fume Hoods;
- Chemical Waste Disposal and Transport;
- Seismic Safety; and
- Mechanical and Electrical Safety.

Other inspections are also conducted. Examples of these include Category A chemical inspections (https://ucla.app.box.com/ehs-cat-a-inspection-checklist) and unannounced PPE inspections (https://ucla.app.box.com/ehs-ppe-compliance-checklist). Once the inspection is completed, EH&S issues a Laboratory Inspection Report via email. The report identifies findings in the laboratory, both serious and non-serious. Serious findings are those that have the potential to lead to serious injuries or be of critical importance in the event of an emergency. These findings must be immediately corrected. Non-serious findings must be corrected within 30-days. Any finding that requires a "Facilities Service Request" (FSR) for completion should be submitted by the Principal Investigator. Include in the FSR that this is a health and safety issue so that it is prioritized by Facilities. Once a FSR is placed please contact your EH&S Lab Safety Officer so that the finding can be added to the FSR database where it will be expedited by Facilities Management. A copy of the most recent Inspection Report should be maintained as part of the records either electronically or inside the Laboratory Safety Manual. EH&S encourages laboratories and departmental safety coordinators to conduct their own audits and inspections. Any reports from these departmental inspections should also be maintained in the Laboratory Safety Manual.

NOTIFICATION AND ACCOUNTABILITY

The compliance program requires that PIs/Laboratory Supervisors and other responsible parties take appropriate and effective corrective action upon receipt of written notification of inspection findings. Serious findings are required to be corrected within 48-hours; non-serious findings must be corrected within 30-days. Failure to take corrective actions within the required timeframe will result in a repeat finding and an escalation of the notification to the Department Chair, Dean and Vice-Chancellor for Research. Depending on the severity of the finding, the EH&S Director, in consultation with the Vice-Chancellor for Research and Office of the Vice Chancellor Safety Oversight Committee (OSOC), may temporarily suspend research activities until the finding is corrected. In some cases, the PI may be required to provide a corrective action plan to the Laboratory Safety Committee prior to resumption of research activities.

LABORATORY SAFETY COMPLIANCE PROCEDURE

The faculty-led Office of the Vice Chancellor Safety Oversight Committee (OSOC) has developed a Chemical and Physical Safety Compliance Procedure in order to maintain a safe working environment and to be in compliance with federal, state, and university regulations. This new procedure institutes a three tiered course of action to escalate findings that are not resolved within the required time frame.

LABORATORY SAFETY COMPLIANCE PROCEDURE IMPLEMENTATION PLAN

The Office of the Vice Chancellor Safety Oversight Committee (OSOC) is charged with promoting a safe work environment for all staff working in research and teaching laboratories on campus. In an effort to ensure that issues identified during lab safety inspections are adequately addressed and corrected within a timely matter, the committee established a 3-tiered Laboratory Safety Compliance Procedure (LSCP,https://vcr.ucla.edu/documents/bp-lab-safety-compliance-2014-01-08).

In order to provide a highly responsive process, the OSOC has delegated administration of the first two tiers of the procedure to be overseen by the campus Chemical and Physical Safety Committee (CPSC). Both the OSOC and CPSC are faculty-led committees. While the 3-tiered procedure is designed to provide a progressive compliance process, it may be by-passed in the event of significant disregard for safety by a PI or the PI's associated group that results in a condition that is immediately dangerous to life and health (IDLH).

Any egregious findings will be reported to the Chair immediately for review at the discretion of EH&S. This may result in suspension of the PI's laboratory activities, in whole or in part, by EH&S in accordance with UCLA Policy 811 (http://www.adminpolicies.ucla.edu/pdf/811.pdf)), with concurrence of the OSOC or appropriate Subcommittee and the Director of Environment, Health & Safety, without instituting the LSCP. Should this occur, the PI will be required to appear before the OSOC or an appropriate Subcommittee before laboratory activities may resume.
The tiers are defined below.

TIER ONE

When a repeat issue of noncompliance by a group has been identified by the LSO during an inspection, a Tier One Memorandum may be issued.

The campus Chemical Hygiene Officer (CHO) will provide the Chair of the CPSC with a report indicating which operations have safety findings that qualify as a repeat issue. Repeat issues that require consideration from the Chair must include, but are not limited to the following:

- All findings which have not been corrected within 90 days of the initial inspection
- Any serious findings which have not been corrected within 72 hours of the initial inspection

Note: Corrections that require infrastructure upgrades will be considered on a case-by-case basis and alternative risk mitigation strategies may be approved by the CPSC (or a

subcommittee consisting of at a minimum, the Chair, the CHO, and a third committee member to be appointed by the Chair) and the EH&S Director.
Once a report has been issued to the CPSC, the committee may move to issue a Tier One Memo or defer issuance of the memo. If the committee wishes to defer, it must establish a rationale for deferring issuance and set a time for re-evaluation.

A Tier One Memorandum will be sent to the PI and his/her Department Chair informing them of the noncompliance issue(s) and of the potential for suspension of operations. The memorandum will indicate the item(s) of noncompliance and indicate a new timeframe for implementing corrective action.

A written response to the Tier One memo is required. The response should contain details regarding either the corrective action taken or plans to take corrective action. Failure to respond within the stated time period (for non-serious issues, 15 days from the date of issue will be used as a standard but this can be changed as determined by the sub-committee) may escalate the memorandum level to Tier Two. Lack of corrective action within the prescribed problem-resolution period following a Tier One Memorandum may result in the issuance of a Tier Two Memorandum. If the committee wishes to defer issuance of a Tier Two memo, it must establish a rationale for deferring issuance and set a time for re-evaluation.

Should the item(s) of noncompliance be corrected within the specified timeline the CPSC will issue a Resolution Memorandum indicating that corrective action has been taken and verified by EH&S. Since corrective action must be verified by EH&S, labs should provide sufficient time for EH&S to respond to claims of corrective action (one business day).

TIER TWO

A Tier Two Memorandum will be sent to the PI and his/her Department Chair informing them of the noncompliance issue(s) and of the potential for suspension of operations. This notice will be sent to the PI informing him/her that this is a repeat item of noncompliance that was not resolved in response to the Tier One memo. The PI, or their designee, must provide a formal written response to the CPSC and EH&S as to the reasons for a second instance of non-compliance and/or why the previous corrective action(s) was/were ineffective and what further corrective action(s) will be implemented to prevent recurrence. In addition, the Principal Investigator (or other responsible manager) will be asked, along with the Department Chair, to appear before a sub-committee of the CPSC to discuss the proposed corrective action plan. The Committee will offer recommendations and/or additional requirements to the Principal Investigator to ensure future compliance.

Failure to respond within the stated time period (for non-serious issues, 15 days from the date of issue will be used as a standard but this can be changed as determined by the sub-committee) may escalate the memorandum level to Tier Three. Lack of corrective action within the prescribed problem-resolution period following a Tier Two Memorandum will result in the CPSC sending a report to the OSOC detailing the issues related to repeat non-compliance and recommending issuance of a Tier Three Memorandum. If the committee wishes to defer its recommendation to the OSOC for escalation to Tier Three, it must establish a rationale for postponement of a recommendation and set a time for re-evaluation.

Should the item(s) of noncompliance be corrected within the specified timeline the CPSC will issue a Resolution Memorandum indicating that corrective action has been taken and verified by EH&S. Since corrective action must be verified by EH&S, labs should provide sufficient time for EH&S to respond to claims of corrective action (24 hours minimum).

TIER THREE

Upon recommendation of the CPSC, the OSOC will review cases where safety issues are not resolved following a Tier Two Memorandum. Should the OSOC agree with CPSC regarding non-compliance, they will issue a Tier Three Memorandum.

This notice will be sent to the Principal Investigator, the Department Chair, and the Vice Chancellor for Research informing them of the continuing noncompliance and recommending that the Principal Investigator's operations be suspended until corrective action is taken. The Vice Chancellor for Research will decide on the course of action following consultation with the OSOC and the Director of EH&S and will provide authority and instruction on enacting suspensions. During the suspension period, the Principal Investigator and Department Chair will be instructed to appear before the OSOC to explain why the operation should be reinstated and to present a formal written corrective action plan.

RECORDKEEPING REQUIREMENTS

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

1. Accident records;
2. Measurements taken to monitor employee exposures;
3. Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations;
4. Inventory and usage records for high-risk substances should be kept;
5. Any medical consultation and examinations, including tests or written opinions required by CCR, Title 8, Section 5191 (https://www.dir.ca.gov/title8/5191.html); and
6. Medical records must be retained in accordance with the requirements of state and federal regulations.

CHAPTER 9: HAZARDOUS CHEMICAL WASTE MANAGEMENT

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, or RCRA. Local enforcement authority is administered by the Los Angeles County Health Hazardous Materials Division.

HAZARDOUS WASTE PROGRAM

The EH&S Hazardous Materials Program manages the shipment and disposal of all hazardous waste generated on campus. Each laboratory employee must comply with the campus Hazardous Waste Management Program requirements and all applicable regulations. A regular pick-up service is provided to most research buildings equipped with wet labs, and a pick-up is available upon request to other locations where hazardous waste is generated.

Laboratory personnel are responsible for identifying waste, labeling it, storing it properly in the laboratory, and transporting waste to their designated pick-up location on time. Laboratory clean-outs and disposal of high hazard compounds (e.g. expired peroxide forming chemicals, dried picric acid, or abandoned unknown chemicals) must be scheduled in advance, and fees for these services are sometimes applied. The PI/Laboratory Supervisor is responsible for coordinating the disposal of all chemicals from his/her laboratories prior to closing down laboratory operations.
A video detailing the hazardous waste program at UCLA can be found at the EH&S Online Video page (https://www.ehs.ucla.edu/training/videos).

DEFINITION OF HAZARDOUS WASTE

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

- Corrosive: pH < 2 or >12.5[*]

[*]There are additional restrictions on the disposal of substances with a non-neutral pH; see the section on Drain Disposal, below.

- Ignitable: liquids with flash point below 60º C or 140º F [e.g. Methanol, Acetone]
- Reactive: unstable, explosive, reacts violently with air or water, or produces a toxic gas when combined with water [e.g., Sodium metal]
- Toxic: Determined by toxicity testing [e.g., Mercury]

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 (see the section below titled "Wastes that Require Special Handling").

EXTREMELY HAZARDOUS WASTE

Certain compounds meet an additional definition known as "extremely hazardous waste". This list of compounds includes carcinogens, pesticides, and reactive compounds, among others (e.g., 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 the Federal lists are included in the EH&S list of extremely hazardous waste (https://www.ehs.ucla.edu/hazwaste/types/extremely-hazardous).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.

PROPER HAZARDOUS WASTE MANAGEMENT

TRAINING

All personnel who are responsible for handling, managing or disposing of hazardous waste must attend training **prior** to working with these materials. The Hazardous Chemical Waste training, which is also a component of the Laboratory Safety Fundamental Concepts course, covers the hazardous waste program requirements and includes training on the container labeling program, or online tag program (*https://ucla.app.box.com/ehs-waste-fact-sheet*). See the EH&S website (www.ehs.ucla.edu) for the training schedule and course description.

WASTE IDENTIFICATION

All the chemical constituents in each hazardous waste stream must be accurately identified by knowledgeable laboratory personnel. This is a critical safety issue for both laboratory employees and the waste technicians that 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 workers must consult the PI/Laboratory Supervisor, the Chemical Hygiene Officer or the Hazardous Materials Manager. In most cases, careful documentation and review of all chemical products used in the experimental protocol will result in accurate waste stream characterization.

The manufacturer's SDS provides detailed information on each hazardous ingredient in laboratory reagents and other chemical products, and also the chemical, physical, and toxicological properties of that ingredient. Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip) 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 Materials Program Manager.

LABELING

UCLA utilizes the UC system-wide Waste Accumulation Storage Tracking electronically (WASTe). Information on how to use WASTe is included in the Hazardous Chemical Waste and Laboratory Safety Fundamental Concepts course and online (*https://www.ehs.ucla.edu/training/division-specific-training-cf/training/schedule/#Laboratory_Safety*).

Online Tag Program

How to Create an Account

Waste Accumulation Storage Tracking electronically (WASTe) accounts are maintained under the name of the PI (see *https://ucla.app.box.com/ehs-waste-fact-sheet*). Employees should ascertain if an account has already been established for their PI and associated laboratory(s). If a new account needs to be established please contact the Hazardous Waste Manager at hazardousmaterials@ehs.ucla.edu.

How to Use WASTe

- Once an account 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 should not be used. 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 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, 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

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 that it should be located in an area that is supervised and is not accessible to the public. Other SAA requirements include:

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. According to State law, the maximum amount of waste that can be stored in a SAA is 55 gallons of a hazardous waste or 1 liter of extremely hazardous waste. If you reach these volumes for a specific waste stream, you must dispose of the waste within 3 days

4. The maximum amount of flammable solvents allowed to be stored in a laboratory outside a flammable storage cabinet is 10 gallons; this figure also includes waste solvents
5. All hazardous waste containers in the laboratory must be kept closed when not in use
6. Hazardous waste streams must have compatible constituents, and must be compatible with the containers that they are stored in
7. Hazardous liquid waste containers must be stored in secondary containment at all times.
8. Containers must be in good condition with leak-proof lids
9. Containers must be less than 90% full
10. Dry wastes must be double-bagged in clear, 3-mil plastic bags (these do not require secondary containment)

SEGREGATION

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

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

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

INCOMPATIBLE WASTE STREAMS

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

Some common incompatible waste streams include:

- Oxidizers added to any fuel can create an exothermic reaction and explode. The most frequent is acids oxidizing flammable liquids. For this reason, all flammable liquids are pH tested before they are consolidated.

- Piranha etch solution is a specific waste stream that contains sulfuric acid and hydrogen peroxide, which form a reactive mixture that is often still fuming during disposal. For this waste stream, and other reactive mixtures like it, vented caps are mandatory.

WASTES THAT REQUIRE SPECIAL HANDLING

Unknowns

Unlabeled chemical containers and unknown/unlabeled wastes are considered unknowns, and additional fees must be paid to have these materials analyzed and identified. These containers must be labeled with the word “unknown”. A $65 per container charge is incurred for disposal of unknown wastes. **Never** mix unknowns for any reason. When disposing of these chemicals, the laboratory must complete a recharge order request or P39 form (https://ucla.app.box.com/ehs-recharge-order-request).

Peroxide Forming Chemicals

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

Each container of peroxide forming chemicals should be dated with the date received and the date first opened. There are four classes of peroxide forming chemicals, with each class having different management guidelines.

Ensure containers of PFCs are kept tightly sealed to avoid unnecessary evaporation, as this inhibits the stabilizers that are sometimes added. Visually inspect containers periodically to ensure that they are free of exterior contamination or crystallization. PFC containers must be disposed of prior to expiration date. If old containers of peroxide forming chemicals are discovered in the laboratory, (greater than two years past the expiration date or if the date of the container is unknown), **do not handle the container**. If crystallization is present in or on the exterior of a container, **do not handle the container**. Secure it and contact the **EH&S Hotline at 310-825-9797** for pick-up and disposal. Disposal of expired peroxide-forming chemicals may incur a charge of $100 per container. When disposing of these chemicals, the laboratory must complete a recharge order request or P39 form (https://ucla.app.box.com/ehs-recharge-order-request).

Dry Picric Acid

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

If an old or previously unaccounted for bottle of picric acid is 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 Hotline at 310-825-9797**immediately. Secure the area and restrict access to the container until it can be evaluated by EH&S personnel.

Explosives and Compounds with Shipping Restrictions

A variety of other compounds that are classified as explosives or are water or air reactive are used in research laboratories. These compounds often have shipping restrictions and special packaging requirements. When disposing of these compounds, employees must ensure that they are stored appropriately for transport. Flammable metals must be completely submerged in oil before they are brought to a waste pick-up. Many pyrophoric and reactive compounds can be stabilized using a quenching procedure prior to disposal (see Appendix F, page F-10 for further details).

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 with the Chemical Hygiene Officer and the Hazardous Materials Program Manager for disposal considerations of these compounds.

Chemotherapy Waste

Pourable chemotherapy/oncology chemicals should be left in their original container and may be brought to the hazardous waste pick-up. Place the bottles in the designated plastic container for bulk chemotherapy waste (usually a five-gallon, sealable bucket), and bring it to hazardous waste pick-up.

Medical devices and supplies that are associated with patient treatment, including tubes, empty containers, syringes, and sharps that are also contaminated with chemotherapy drugs should not be brought to the hazardous waste pick-up; these are disposed via the medical waste program. Because chemotherapy drugs are potent toxins, special yellow barrels are available for these materials, which are usually located in medical waste storage areas. For more information, contact the Biosafety Program at 310-825-3323 or by emailing biosafety@ehs.ucla.edu.

MANAGING EMPTY CONTAINERS

Empty containers that held Extremely Hazardous waste must be managed as hazardous waste, and brought to the waste pick-up. Do not rinse or reuse these containers. Empty containers 5 gallons in size or more should also be managed as hazardous waste, and brought to a hazardous waste pick-up.

All other chemical 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 rinsate collected as hazardous waste. Then the labels should be completely defaced (remove it or mark it out completely). Dispose or recycle rinsed plastic or glass containers as regular trash or in a campus recycling bin. To request a recycling bin, go to: http://www.sustain.ucla.edu/our-initiatives/recycling-and-waste-management/recycling-bin-request-form/

TRANSPORTATION

It is a violation of DOT regulations to transport hazardous waste in personal vehicles, or to carry hazardous waste across campus streets that are open to the public. As a result, EH&S provides pick-up services for all hazardous waste generators. These routine waste pick-ups are for routinely generated research wastes. Special pick-ups and laboratory clean-outs are available upon request for large volumes (more than 30 containers or 50 gallons). Labs that are not on the routine pick-up schedule must call 310-206-1887 for a pick-up.

When transporting waste to the pick-up location, inspect all containers to make sure that they are safe to transport. Verify that each container has an accurate waste tag, and the containers are clean and free of residue and do not show any signs of bulging, fuming, or bubbling. Use only a stable, heavy duty cart for transporting waste. Containers should be segregated on carts, and carts should be equipped with secondary containment. Do not overload a cart or stack containers more than one level high. Never leave the waste unattended after departing the laboratory. Employees must wear long pants and closed toe shoes (and carry gloves with them) when transporting waste. An appropriate lab coat, gloves and eye protection must be carried as a spill response measure but should not be worn while transporting waste.

DISPOSAL

Frequent disposal will ensure that waste accumulation areas in labs are managed properly, and that maximum storage volumes are not exceeded. UCLA 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 brought to the next designated pick-up. Once an experiment or process is completed, all partially filled containers should be brought to the next scheduled pick-up for that building.

Acceptable Wastes for a Routine Pick Up

EH&S accepts the following materials at a routine pick-up:

- 30 containers or less of research generated waste
- Liquid waste in suitable containers that are clean, free of contamination, and have a leak proof cap
- Dry waste that is double bagged in clear 3-mmplastic
- Chemical contaminated sharps (with no infectious or biohazardous contamination) in a rigid sharps container
- Treated infectious waste streams or deactivated biological agents that are mixed with chemical wastes
- Batteries
- Small hand-held electronic devices
- Fluorescent and other lamps

Wastes that will **not** be accepted at a routine pick-up location include:

- Biohazardous waste (medical waste, infectious materials or biohazardous agents) - contact Biosafety at 310-206-3929 or biosafety@ehs.ucla.edu
- Radioactive Wastes - contact Radiation Safety at 310-825-5689 or radiationsafety@ehs.ucla.edu
- Controlled Substances - contact the Reagan Hospital Pharmacy Vault at 310-207-8513
- Reactive waste streams without a properly vented cap, or containers that are bulging, fuming or bubbling
- Leaking, overflowing, or contaminated containers, or containers that are compromised
- Bags that have protruding glass or other sharps, or bags that are ripped or punctured
- Wastes that require special handling procedures or have shipping restrictions
- Waste streams in incompatible containers
- Unknowns and expired PFCs without a recharge ID

A current pick-up schedule can be found on the EH&S Hazardous Waste page:
https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule

HAZARDOUS WASTE MINIMIZATION

UCLA is a large quantity generator of hazardous waste. In order to meet our permit obligations and our sustainability mission, EH&S has developed a Hazardous Waste Minimization Program, in an effort to minimize the costs, health hazards, and environmental impacts associated with the disposal of hazardous waste.

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 that can be modified to reduce the amount of hazardous waste generated.

Purchasing Control: Check the inventory of the Surplus Chemical Redistribution Program (*https://www.ehs.ucla.edu/hazwaste/chemicals/surplus*) before new products are ordered. When ordering chemicals, be aware of any properties that may preclude long term storage, and order only exact volumes to be used. Using suppliers who can provide quick delivery of small quantities can assist with reducing surplus chemical inventory. Consider establishing a centralized purchasing program to monitor chemical purchases and avoid duplicate orders.

Inventory Control: Rotate chemical stock to keep chemicals from becoming outdated. Locate surplus/unused chemicals and attempt to redistribute these to other users, or investigate returning unused chemicals to the vendor.

Operational Controls: Review your experimental protocol to ensure that chemical usage is minimized. Reduce total volumes used in experiments; employ small-scale procedures when possible. Instead of wet chemical techniques, use instrumental methods, as these generally require smaller quantities of chemicals. Evaluate the costs and benefits of off-site analytical services. Avoid mixing hazardous and non-hazardous waste streams. Distill and 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
- Gel Green and Gel Red are recommended in place of ethidium bromide

DRAIN DISPOSAL

UCLA 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. This applies to weak acid and base solutions. As indicated in previous sections, EPA hazardous waste definitions specify that materials with a pH between 2 and 12.5 are not hazardous wastes. However, drain disposal of these materials is still not permitted, because local industrial waste-water discharge requirements have more restrictive pH thresholds. In addition, acid and base neutralization is considered waste treatment, a process that is strictly regulated by the EPA (see "Bench Top Treatment" below). Contact EH&S for specific questions about drain disposal variances.

Drain disposal of properly disinfected infectious or bio-hazardous liquids is acceptable, if disinfection is conducted as specified by the EH&S Biosafety Program, and the liquids disposed contain no other hazardous constituents.

BENCH TOP TREATMENT

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. The EPA requirements for treating hazardous waste in laboratories generally follow the "Prudent Practices in the Laboratory 1995" (p. 160-171) National Research Council procedures, or other peer-reviewed scientific publications. The quantity of waste treated in one batch cannot exceed 5 gallons of liquid or 18 kilograms of solid/semi-solid waste. As treatment may result in residuals that may have to be managed as hazardous waste, all residual hazardous waste must be handled according to UCLA's Hazardous Waste Program requirements.

MERCURY THERMOMETER EXCHANGE PROGRAM

Cleaning up spilled mercury from a broken thermometer is the most frequent EH&S Haz Mat response. Mercury is a potent neurotoxin and environmental contaminant, and UCLA has a goal of having a mercury free campus. EH&S will exchange mercury thermometers with non-mercury thermometers free of charge. To request an exchange of mercury thermometers, fill out the form at: https://www.ehs.ucla.edu/hazwaste/chemicals/thermometer.

CHAPTER 10: ACCIDENTS AND CHEMICAL SPILLS

OVERVIEW

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

For all incidents requiring emergency response, call UCPD at 911 from a campus phone or 310- 825-1491 from off-campus or cell phones.

ACCIDENTS

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 near misses must be reported to the **EH&S Hotline at 310-825-9797**. EH&S will conduct an accident investigation and develop recommendations and corrective actions to prevent future accidents. At a minimum, each laboratory must have the following preparations in place:

1. Fully stocked first aid kit
2. Posting of emergency telephone numbers and locations of emergency treatment facilities, including Occupational Health Facility (OHF, in CHS 67-120)
3. Training of staff to accompany injured personnel to medical treatment site and to provide medical personnel with copies of Safety Datasheets (SDS) for the chemical(s) involved in the incident

Accident Prevention Methods	
Do	**Don't**
• Always wear appropriate eye protection • Always wear appropriate laboratory coat • Always wear appropriate gloves • Always wear closed-toe shoes and long 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	• 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 • Never eat, drink, chew gum or tobacco, smoke, or apply cosmetics in the laboratory • Never use damaged glassware or other equipment

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

Serious occupational injuries, illnesses, and exposures to hazardous substances must be reported to the EH&S Hotline at 310-825-9797 within 8 hours. EH&S will report the event to Cal/OSHA, investigate the accident, and complete exposure monitoring if necessary. Serious injuries include those that result in permanent impairment or disfigurement, or require hospitalization. Examples include amputations, lacerations with severe bleeding, burns, concussions, fractures and crush injuries. As soon as PIs/Laboratory Supervisors are aware of a potentially serious incident, they must contact EH&S. Serious injury posters (https://www.ehs.ucla.edu/doc/1.jpg/view) are displayed across campus with instructions on reporting injuries to EH&S to ensure that all serious injuries are reported to Cal/OHSA within 8 hours.

FIRE-RELATED EMERGENCIES

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

1. Pull the fire alarm pull station **and call 911 from a campus phone or 310-825-1491 from an off-campus or cell phone** to notify the Fire Department;
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;

3. Remain safely outside the affected area to provide details to emergency responders; and
4. Evacuate the building when the alarm sounds. **It is against state law to remain in the building when the alarm is sounding.** If the alarm sounds due to a false alarm or drill, you will be allowed to re-enter the building as soon as the Fire Department determines that it is safe to do so. **Do not go back in the building until the alarm stops and you are cleared to reenter.**

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 Hotline at **310-825-9797 within 8 hours every time a fire extinguisher is discharged**.

CHEMICAL SPILLS

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

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

Factors to Consider Before Spill Clean-Up

- Size of spill
- Quantity of chemical
- Toxicity
- Volatility
- Clean up materials available
- Training of responders

Effective emergency response to these situations is imperative to mitigate or minimize adverse reactions when chemical incidents occur. After emergency procedures are completed, all personnel involved in the incident should follow UCLA chemical exposure procedures as appropriate (see Chapter 4: Chemical Exposure Assessment).

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, consult the SDS. Obtain medical assistance as indicated. Remember to wear appropriate PPE before helping others. PIs/ Laboratory Supervisors must review all exposure situations, make sure affected employees receive appropriate medical treatment and/or assessment, and arrange for containment and clean-up of the chemical as appropriate.

Highly Toxic Chemical Spills
Do not try to clean up spills of any size.
All spills require emergency response:

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

Broken Mercury Thermometers should not be cleaned by the laboratory. Please try to prevent the spread of the spilled mercury, and do not allow people to walk through the contaminated area. Call **911** from a campus phone or **310-825-1491** from an off-campus or cell phone for assistance.

Large chemical spills include spills of larger quantities, spills of any quantity of highly toxic chemicals, or chemicals in public areas or adjacent to drains. Large spills require emergency response. Call **911** from a campus phone or **310-825-1491** from an off-campus or cell phone for assistance.

WHAT TO DO WITH A SMALL CHEMICAL SPILL (<1 LITER)

Laboratory personnel can clean up small spills if trained and competent to do so. Small spills include chemical spills that are up to 1 liter in size and of limited toxicity, flammability, and volatility. If respiratory protection is needed for spill clean-up, the spill is too large to be handled by laboratory personnel – dial **911 from a campus phone or 310-825-1491 from an off-campus or cell phone.** Commercial chemical spill kits are available, which include protective equipment such as goggles and gloves, neutralizing and absorbing materials, bags, and scoops. You can also make your own spill kits to include the materials described below.

Chemical Spills:

- Sodium Bicarbonate
- Citric Acid
- Vermiculite or other diking material
- pH paper
- 1 pair neoprene or nitrile gloves
- 1 pair goggles
- 1 scoop
- Spill pillows, sorbent pads
- Disposable shoe covers (plastic bags may work)

1. Evacuate all non-essential persons from the spill area
2. If needed, call for medical assistance by dialing **911** from a campus phone or **310-825-1491** from an off-campus or cell phone.
3. Help anyone who may have been contaminated. Use emergency eyewashes/showers by flushing the skin or eyes for *at least 15 minutes*.
4. Post someone just outside the spill area to keep people from entering. Avoid walking through contaminated areas.
5. You must have the proper protective equipment and clean-up materials to clean-up spills. Check the chemical's SDS Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip) in your laboratory or online for spill clean-up procedures, or call the **EH&S Hotline at 310-825-9797** for advice.

6. Turn off sources of flames, electrical heaters, and other electrical apparatus, and close valves on gas cylinders if the chemical is flammable.
7. Confine the spill to a small area. Do not let it spread.
8. 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 respond and clean up the spill.
9. Wear personal protective equipment, including safety goggles, gloves, and a laboratory coat or other protective garment to clean-up the spill.
10. Work with another person to clean-up the spill. Do not clean-up a spill alone
11. DO NOT ADD WATER TO THE SPILL.
12. Use an appropriate kit to neutralize and absorb inorganic acids and bases. For other chemicals, use the appropriate kit or absorb the spill with sorbent pads, paper towels, vermiculite, dry sand, or diatomaceous earth. See below for additional information.
13. Collect the residue and place it in a clear plastic bag. Double bag the waste and label the bag with the contents. Take it to the Chemical Waste Pick-up (https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule) for your building.

WEAK INORGANIC ACID OR BASE SPILL CLEAN UP PROCEDURE

1. Wear gloves, goggles, laboratory coat and shoe covers.
2. To clean-up a spill of weak inorganic acid or base, neutralize the spilled liquid to pH 5 to 8 using a **Neutralizing Agent** such as:
    - Sodium bicarbonate
    - Sodium bisulfate
    - Soda ash
    - Citric acid
3. Absorb the neutralized liquid with an **Absorbent** such as:
    - Sorbent pads
    - Sponges
    - Diatomaceous earth
    - Paper towels
    - Dry sand
    - Vermiculite
4. Rinse the absorbent pads or sponges in a sink with water. Scoop or place the other absorbent materials into a clear plastic bag. Double bag and tag the bag with a chemical waste tag. Take it to your chemical waste pick-up. Refer to the UCLA Hazardous Waste Pick-Up Schedule (*https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule*) for the time and date of the pick-up for your building or call the **EH&S Hotline at 310-825-9797**.

Solvent Spill Clean Up Procedure

1. Absorb the spill with a non-reactive material such as:
    - Vermiculite
    - Dry sand
    - Paper towels
    - Sponges
2. Package as described above. Do not rinse or dispose of any chemicals down the sink or into any drain.

WHAT TO DO WITH A LARGE CHEMICAL SPILL (>1 LITER)

Large chemical spills require emergency response. Call 911 from a campus phone or 310-825-1491 from an off-campus or cell phone. If the spill presents a situation that is immediately dangerous to life or health (IDLH) or presents a significant fire risk, activate a fire alarm, evacuate the area and wait for emergency response to arrive.

- Remove the injured and/or contaminated person(s) and provide first aid
- Call for emergency medical response
- As you evacuate the laboratory, close the door behind you, and:
    - Post someone safely outside and away from the spill area to keep people from entering

- Confine the spill area if possible and safe to do so
    - Leave on or establish exhaust ventilation
    - If possible, turn off all sources of flames, electrical heaters, and other electrical equipment if the spilled material is flammable
    - Avoid walking through contaminated areas or breathing vapors of the spilled material
- Any employee with known contact with a particularly hazardous chemical must shower, including washing of the hair as soon as possible unless contraindicated by physical injuries

APPENDIX A: GLOSSARY

ACGIH - The American Conference of Governmental Industrial Hygienists is a voluntary membership organization of professional industrial hygiene personnel in governmental or educational institutions. The ACGIH develops and publishes recommended occupational exposure limits each year called Threshold Limit Values (TLVs) for hundreds of chemicals, physical agents, and biological exposure indices.

ACTION LEVEL - A concentration designated in Title 8, California Code of Regulations for a specific substance, calculated as an eight (8)-hour time weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

AEROSOL - Liquid droplets or solid particles dispersed in air that are of fine enough size (less than 100 micrometers) to remain dispersed for a period of time.

ASPHYXIANT - A chemical (gas or vapor) that can cause death or unconsciousness by suffocation. Simple asphyxiants, such as nitrogen, either use up or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.

"C" OR CEILING - A description usually seen in connection with a published exposure limit. It refers to the concentration that should not be exceeded, even for an instant. It may be written as TLV-C or Threshold Limit Value - Ceiling. (See also Threshold Limit Value).

CARCINOGEN - A cancer-producing substance or physical agent in animals or humans. A chemical is considered a carcinogen or potential carcinogen if it is so identified in any of the following:

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

CHEMICAL HYGIENE OFFICER - An employee who is designated by the employer and who is qualified by training or experience to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan.

CHEMICAL HYGIENE PLAN - A written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment, and work practices that

(1) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (2) meets the requirements of OSHA regulation 29 CFR 1910.1450.

COMBUSTIBLE LIQUID - Any liquid having a flashpoint at or above 100°F (37.8°C) but below 200°F (93.3°C) except any mixture having components with flashpoints of 200°F or higher, the total volume of which make up 99% or more of the total volume of the mixture.

COMPRESSED GAS - A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70°F (21.1°C), or; a gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C), or; a liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM D-323-72.

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

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

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

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

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

1. Flammable aerosol - an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;
2. Flammable gas - a gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13% by volume or less; or a gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12% by volume, regardless of the lower limit;
3. Flammable liquid - any liquid having a flashpoint below 100°F (37.8°C), except any mixture having components with flashpoints of 100°F (37.8°C) or higher, the total of which make up 99% or more of the total volume of the mixture; or

4. Flammable solid - a solid, other than a blasting agent or explosive as defined in1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and, when ignited, burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a greater than one-tenth of an inch per second along its major axis.

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

1. Tagliabue Closed Tester (See American National Standard Method of Test for Flashpoint by Tag Closed Tested, Z11.24-1979 (ASTM D-56-79) for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100°F (37.8°C) or that contain suspended solids and do not have a tendency to form a surface film under test;
2. Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7-1979 (ASTM D-73-79) for liquids with a viscosity equal to or greater than 45 SUS at 100°F (37.8°C), or that contain suspended solids, or that have a tendency to form a surface film under test; or,
3. Setaflash Closed Tester (See American National Standard Method of Test for Flashpoint of Setaflash Closed Tester (ASTM D-3278-78)). Organic peroxides, which undergo auto accelerating thermal decomposition, are excluded from any flashpoint determination methods specified above.

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

GLOBALLY HARMONIZED SYSTEM (GHS) - The GHS is a system for standardizing and harmonizing the classification and labeling of chemicals. It is a logical and comprehensive approach to: defining health, physical and environmental hazards of chemicals; creating classification processes that use available data on chemicals for comparison with the defined hazard criteria; and communicating hazard information, as well as protective measures, on labels and Safety Data Sheets (SDS).

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

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

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

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

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

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

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

1. A substance that has a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each;
2. A substance that has a median lethal dose (LD_{50}) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death

occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each; or

3. A substance that has a median lethal concentration (LC50) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume, or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

OXIDIZER - Is a substance that causes or contributes to combustion of organic material. They often do so by giving up oxygen atoms.

PERMISSIBLE EXPOSURE LIMIT (PEL) - An exposure, inhalation or dermal permissible exposure limit specified in 8 CCR 5155. PELs may be either a time-weighted average (TWA) exposure limit (8-hour), a 15-minute short-term limit (STEL), or a ceiling (C).

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

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

PYROPHORIC -A chemical that is liable to ignite within 5 minutes after coming into contact with air. Many of these compounds will also have an auto-ignition temperature of 130 ºF (54.4 ºC) or lower.

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

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

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

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

SAFETY DATA SHEET (SDS) - Written or printed material concerning a hazardous chemical which is prepared in accordance with paragraph (g) of 29 CFR 1910.1200

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

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

4. It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP.

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

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

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

THRESHOLD LIMIT VALUE (TLV) - Airborne concentration of substances devised by the ACGIH that represents conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLVs are advisory exposure guidelines, not legal standards, that are based on evidence from industrial experience, animal studies, or human studies when they exist. There are three different types of TLVs: Time-Weighted Average (TLV-TWA), Short-Term Exposure Limit (TLV-STEL), and Ceiling (TLV-C). (See also PEL).

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

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

APPENDIX B: UCLA POLICY 905 – RESEARCH LABORATORY PERSONAL SAFETY AND PROTECTIVE EQUIPMENT†

†UCLA Policy 905 – Research Laboratory Personal Safety and Protective Equipment can be obtained at: https://ucla.app.box.com/ehs-ucla-ppe-policy.

UCLA Policy 905: Research Laboratory Personal Safety and Protective Equipment

Issuing Officer: Vice Chancellor for Research
Responsible Dept: Environment, Health & Safety
Effective Date: March 31, 2014
Supersedes: UCLA Policy 905, dated 2/1/2010

I. REFERENCES

1. University of California Policy on Personal Protective Equipment (06/12/2013);
2. University of California Policy on Management of Health, Safety and the Environment (10/28/2005);
3. Guiding Principles to Implement the University of California Policy on Management of Health, Safety and the Environment (10/28/2005);
4. UCLA Policy 811, Environmental Health and Safety;
5. Code of Federal Regulations, Title 29 CFR, Part 1910, Subpart 1;
6. California Code of Regulations – Subchapter 7. General Industry Safety Orders – Group 16. Control of Hazardous Substances – Article 109. Hazardous Substances and Processes - §5194. Hazard Communication.

II. STATEMENT

The University of California is committed to providing a healthy and safe working environment for all members of the campus community. It is University policy to comply with all applicable health, safety and environmental protection laws, regulations and requirements. The Occupational Safety and Health Administration (OSHA) ensure workplace safety through the enforcement of established federal legislation, and the California Occupational Safety and Health Administration (CalOSHA) operates as the acting regulatory enforcement body under the direction of the OSHA act.

Title 29 of the Code of Federal Regulations, Part 1910, Subpart 1. *Personal Protective Equipment*, states that "protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact." Pursuant to this regulation, and in an effort to prevent workplace injuries and illnesses, UCLA has established this Policy regarding Personal Protective Equipment (PPE) requirements for all campus research laboratory faculty, staff and students.

III. RESPONSIBILITIES

Preventing workplace injuries and illnesses is the responsibility of every member of the campus community. Specific responsibilities are assigned to higher level members of the research and teaching community in order to implement and ensure compliance with this Policy by their subordinate staffs.

The Chancellor has overall responsibility for compliance with health and safety requirements at all facilities and programs under campus control.

The Vice Chancellor for Research is responsible for the implementation of this Policy in all applicable research and teaching laboratories within his or her jurisdiction.

The UCLA Laboratory Safety Committee (LSC) is responsible for promoting a safe working environment in all research and teaching laboratories on campus.

Department Chairpersons are responsible for communicating, promoting and enforcing the Policy in their respective research and teaching areas.

Principal Investigators and laboratory management staff are responsible for complying with this Policy and ensuring their staff receive appropriate training and comply with this Policy as it relates to their research and teaching activities.

All staff members working in laboratory areas are responsible for following laboratory safety requirements and for wearing PPE as outlined in this Policy and in laboratory-specific safety training.

The UCLA Office of Environment, Health & Safety (EH&S) is responsible for inspection of laboratories and enforcement of this Policy. In cases where laboratory activities pose an immediate danger to life or health, designated EH&S staff have the responsibility and authority to order the temporary cessation of the activity until the hazardous condition is abated.

IV. SAFETY REQUIREMENTS

The following requirements pertain to all research and teaching laboratory environments utilizing hazardous chemical, hazardous biological or unsealed radiological materials (see section V., below). The requirements do not apply to those research and teaching laboratories that involve solely mechanical, computer, laser, other non-ionizing radiation, or electrical operations; these hazards will be addressed under separate policies, as appropriate. In addition, these requirements will not apply to laboratories which have been designated as non-hazardous materials use areas. In order to qualify as a non-hazardous materials use area, a laboratory must obtain approval and appropriate labeling from EH&S. EH&S, in cooperation with regulation mandated safety committees, has the final authority for determining whether any specific material is classified as hazardous. Deviations from these requirements, including the defining of specific hazardous materials use areas within rooms, may be permitted under certain conditions and will require express, written approval from EH&S.

A. Full length pants, or equivalent, and close-toed shoes must be worn at all times by all individuals that are occupying the laboratory area. The area of skin between the shoe and ankle should not be exposed.

B. Protective gloves must be worn while utilizing any hazardous chemical, biological or unsealed radiological material. These gloves must be appropriate for the material being used. The Safety Data Sheet (SDS) for the material should be referenced when determining the effectiveness of the type of glove to be used. Additionally, the EH&S website (www.ehs.ucla.edu) offers guidance on glove selection based on material handling as well as links to other resources. This requirement does not apply when working with non-hazardous materials and an open flame or other heat source that might cause injury by melting plastic gloves.

C. Laboratory coats, or equivalent, are required to be worn while working on, or adjacent to, all bench top procedures utilizing hazardous chemicals, biological or unsealed radiological materials. These laboratory coats must be appropriately sized for the individual and be buttoned to their full length. Laboratory coat sleeves must be of a sufficient length to prevent skin exposure while wearing gloves.

D. Flame resistant laboratory coats must be worn when working with any amount of pyrophoric materials, or any amount of flammable liquids near ignition sources. Flame resistant laboratory coats must be worn when working with flammable liquids in amounts that pose a greater than de minimus risk as determined by a risk assessment. It is recommended that cotton (or other non-synthetic material) clothing be worn during these procedures to minimize injury in the case of a fire emergency.

E. Laboratory coats may not be worn outside of a laboratory unless the individual is traveling directly to an adjacent laboratory work area. Protective gloves must not be worn in any public area outside of the laboratory (i.e., hallways, elevators, offices). Gloves should also be removed prior to handling any equipment that could likely result in cross-contamination (e.g., telephones, computer work stations, etc.).

F. Each department or research unit shall be responsible for providing professional laundry services as needed to maintain the hygiene of laboratory coats. They may not be cleaned by staff members or students at private residences or public laundry facilities. Any clothing that becomes contaminated with hazardous materials must be decontaminated before it leaves the laboratory.

G. Eye protection or equivalent engineering controls must be used while handling any hazardous chemical, biological or unsealed radiological materials. All eye protection equipment must be American National Standards Institute (ANSI) approved and appropriate for the work being done.

H. Some operations and procedures may warrant further PPE, as indicated by the SDS, the standard operating procedures for the material being used, facility policies, regulatory requirements, or the EH&S Laboratory Hazard Assessment Tool.

V. DEFINITIONS OF HAZARDOUS MATERIALS

The following materials are defined as hazardous for the purposes of this Policy:

1. Any unsealed radioactive material.
2. Biological materials in the BSL-2 Category, or greater.
3. Chemicals listed as Select Carcinogens and Regulated Carcinogens. (See http://www.dir.ca.gov/Title8/5191.html for the Cal/OSHA criteria for select carcinogens)
4. Chemicals listed as Reproductive Toxicants. (See http://www.oehha.org/prop65/prop65_list/Newlist.html#files for a list of reproductive toxicants and carcinogens identified under California Proposition 65)
5. Chemicals listed as Toxic or Highly Toxic. (See http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10100 for OSHA guidance on identifying Highly Toxic Chemicals)
6. Flammable, air reactive, or water reactive chemicals.
7. Corrosive chemicals in concentrations of one (1) molar or greater.
8. Known significant skin or eye irritants.

This list is to be used as a guideline and allows for some laboratories to be classified as non-hazardous materials laboratories. It does not supersede Cal/OSHA regulations or accepted safe work practices for specific materials. PPE and other safety measures, as appropriate, must be used to protect workers from any and all known hazards that are present in all work-related activities at UCLA. Refer to the California Code of Regulations for additional guidance in developing protective measures for laboratory use of hazardous materials.

Issuing Officer

/s/ James Economou

Vice Chancellor for Research

Questions concerning this policy or procedure should be referred to the Responsible Department listed at the top of this document.

APPENDIX C: UCLA POLICY 907 - PARTICULARLY HAZARDOUS SUBSTANCES‡

‡UCLA Policy 907: Safe Handling of Particularly Hazardous Substances can be accessed at: http://www.adminpolicies.ucla.edu/app/Default.aspx?&id=907

UCLA Policy 907: Safe Handling of Particularly Hazardous Substances

Issuing Officer: Vice Chancellor for Research
Responsible Dept: Environment, Health & Safety
Effective Date: December 9, 2010
Supersedes: New

I. REFERENCES

1. Title 8, California Code of Regulations (CCR), Section 5191 (Occupational Exposures to Hazardous Chemicals in Laboratories; Article 110 (Regulated Carcinogens); Section 5209 (Listed Carcinogens); Section 5203 (Report of Use Requirements); Section 5154.1 (Ventilation Requirements for Laboratory-Type Hood Operations);
2. UCLA Policy 905, Research Laboratory Personal Safety and Protective Equipment;
3. UCLA Policy 811, Environmental Health and Safety;
4. UCLA Laboratory Safety Manual (includes Chemical Hygiene Plan).

II. PURPOSE

This Policy provides general guidance on how to work safely with chemicals that have been designated as "particularly hazardous" by Cal/OSHA. It describes the minimum requirements for the safe storage, use, handling, and disposal of particularly hazardous substances, including spill and accident response procedures. Particularly hazardous substances are defined by Cal/OSHA as: reproductive toxins, acutely toxic substances and select carcinogens, which include regulated carcinogens. Refer to Attachment A, Particularly Hazardous Substances Definitions, for specific definitions.

III. STATEMENT

This Policy is applicable to, and must be adhered to by, all UCLA laboratory workers (i.e., Principal Investigators, laboratory personnel, students, visiting researchers, etc.) who use or work with particularly hazardous substances. Careful handling and stringent controls of these chemicals are essential to protect workers and the environment, and to comply with Cal/OSHA regulations.

Additional safety requirements may apply, depending on the specific chemical. For example, carcinogens that are also highly flammable require both particularly hazardous substance controls as well as fire safety controls. Contact the Office of Environment, Health & Safety (310-825-9797) for guidance on use of chemicals that may require further controls. Information and guidance on handling of particularly hazardous substances can also be found in UCLA's Chemical Hygiene Plan.

IV. RESPONSIBILITIES

Preventing workplace injuries, exposures, and illnesses is the responsibility of every member of the campus community. Specific responsibilities are assigned to more senior members of the research and teaching community in order to implement, and ensure compliance with this Policy by their subordinate personnel.

<u>The Chancellor</u> has overall responsibility for compliance with health and safety requirements at all facilities and programs under campus control.

The Vice Chancellor for Research is responsible for the implementation of this Policy in all applicable research and teaching laboratories within his or her jurisdiction.

The UCLA Laboratory Safety Committee (LSC) has a broad oversight role in overseeing research activities and is responsible for promoting a safe working environment in all research and teaching laboratories on campus, and for developing, updating and maintaining policies applicable to the health and safety of laboratory work.

Department Chairpersons are responsible for communicating, promoting and enforcing this Policy in their respective research and teaching areas.

Principal Investigators and laboratory management staff are responsible for complying with this Policy and ensuring their laboratory personnel receive appropriate training and comply with this Policy as it relates to their research and teaching activities.

All Laboratory Personnel working in laboratory areas are responsible for following laboratory safety requirements, including how to work safely with substances designated as particularly hazardous.

The UCLA Office of Environment, Health & Safety (EH&S) is responsible for inspection of laboratories and for campus compliance with this Policy. In cases where laboratory activities pose an immediate danger to life or health, designated EH&S staff have the responsibility and authority to order the temporary cessation of the activity until the hazardous condition is abated.

The UCLA Chemical Hygiene Officer (CHO), also referred to as the Chemical Safety Officer, is responsible for facilitating necessary reviews of procedures that involve the use of hazardous chemicals. The reviews of procedures should primarily be provided by subject experts as part of a departmental safety committee. The CHO, with the support of other EH&S Research Safety Experts, will support, and assist in the organization of, and provide annual oversight for this process.

V. LABORATORY SAFETY REQUIREMENTS & PROCEDURES

A. Laboratory Specific Standard Operating Procedures

1. Individual laboratory groups must prepare and maintain laboratory-specific standard operating procedures (SOP) for identifying hazards and handling methods to avoid exposure to particularly hazardous substances. The procedures must indicate the designated use areas, limitations on the quantities and procedures used, information on containments, and information on hazards involved. These procedures may be specific to particular substances or generalized over a group of chemicals with similar hazardous properties and use limitations. Chemical-specific procedures must be developed for each Cal/OSHA regulated carcinogen and procedures should be developed for reproductive toxins, acutely toxic materials, and select carcinogens. EH&S can provide additional guidance for specific chemical hazards.
2. A copy of the particularly hazardous substances procedures, including laboratory specific information, and the Material Safety Data Sheets (MSDS) for the chemical(s) used must be readily accessible in the lab.
3 EH&S must be notified immediately via the EH&S Hotline at 310-825-9797 if members of the laboratory become ill or exhibit signs or symptoms associated with exposure to hazardous chemicals used in the laboratory. Affected employees must be provided immediate first aid and medical surveillance within 24-hours of the event.
4. Principal Investigators must identify what classes of particularly hazardous substances are in use in their labs on their Laboratory Hazard Assessment Tool (LHAT), which must be completed as conditions change in the laboratory, or at least once each calendar year.

B. Training and Documentation

1. All laboratory personnel who work with or may be exposed to particularly hazardous substances must be provided laboratory-specific training and information by the Principal Investigator or their designee prior to beginning their initial assignment. Laboratory-specific training should cover specific policies and procedures, etc. and is in addition to the basics covered in the Laboratory Safety Fundamental Concepts training. Records of laboratory-specific training must be maintained in the laboratory and should include an outline of the

topics covered. See http://ehs.ucla.edu/LabTrainingRecord.pdf for a sample documentation form. Training shall include:

- The hazards/toxicological effects associated with the chemicals being used.
- Routine procedures and decontamination methods.
- Emergency response practices and procedures.
- Methods and observations for detecting the presence or release of hazardous chemicals.
- Available protection measures, including appropriate work practices and personal protective equipment (PPE).
- A review of written SOP and MSDSs and the Chemical Hygiene Plan (CHP).
- A review of this Policy.

2. All laboratory personnel are responsible for knowing and complying with all safety guidelines, regulations, and procedures required for the task assigned and for reporting unsafe conditions, accidents or near misses to the Principal Investigator, immediate laboratory management staff or EH&S.
3. Continuing training shall be conducted as needed to maintain a working knowledge of hazards and the safety requirements for all laboratory personnel who work with particularly hazardous substances, including an annual refresher for particularly hazardous substances. Written records must be maintained for each training session. See http://ehs.ucla.edu/LabTrainingRecord.pdf for a sample documentation form.

C. Use in Designated Areas

1. Designated area(s) for use of particularly hazardous substances must be formally established by developing SOPs and posting appropriate signage. This designated area(s) may be an entire laboratory, a specific work bench, or a chemical fume hood. When particularly hazardous substances are in use, access to the designated area shall be limited to personnel following appropriate procedures and who are trained in working with these chemicals.
2. Access to areas where particularly hazardous substances are used or stored must be controlled by trained employees. Working quantities of particularly hazardous substances should be kept as small as practical and their use should be physically contained as much as possible, usually within a laboratory fume hood or glove box. It is the responsibility of each Principal Investigator, or their designee, to train and authorize their staff for these operations and to maintain documentation of this training and authorization.
3. Signage is required for all containers, designated work areas and storage locations. Sign wording must state the following as appropriate for the specific chemical hazard:

   "DANGER, CANCER HAZARD – SUSPECT AGENT"

   "DANGER, CANCER HAZARD – REGULATED CARCINOGEN"

   "DANGER, REPRODUCTIVE TOXIN"

   "DANGER, ACUTE TOXIN"

   Entrances to designated work areas and storage locations must include signage, "AUTHORIZED PERSONNEL ONLY", in addition to the above specific hazard warning wording. Signage templates can be obtained from the UCLA Chemistry and Biochemistry safety webpage.
4. Work surfaces should be stainless steel, plastic trays, dry absorbent plastic backed paper, chemically resistant epoxy surfaces, or other chemically impervious material.
5. Protocols, procedures, and experiments must be designed and performed in a manner to safely maintain control of the particularly hazardous substances. Laboratory personnel must specifically consult with their Principal Investigators if a special hazard is involved (e.g., material under pressure) or if they are uncertain of the potential hazards.

D. Personal Protective Equipment (PPE)

1. PPE must be sufficient to protect eyes and skin from contact with the hazardous agents. At minimum, safety glasses, lab coat, long pants, closed toe shoes, and gloves are required when working with particularly hazardous substances. See UCLA Policy 905, Research Laboratory Personal Safety and Protective Equipment for more information. Goggles may be required for processes in which a splash or spray hazard may exist and flame resistant lab coats may be required if the chemicals being used are flammable.
2. Refer to the specific chemical's MSDS and SOP for specific information on additional PPE and glove selection.
3. Contaminated PPE and clothing must be disposed of or decontaminated prior to removal from the designated work area. While small spots of contamination may be cleaned in the lab, grossly contaminated lab coats may need to be disposed of as dry hazardous waste. Refer to UCLA Policy 905 and the Chemical Hygiene Plan for guidance on handling contaminated protective apparel and other PPE.

E. Engineering Controls

1. Bench top work with particularly hazardous substances should be avoided whenever practical in favor of contained systems (such as fume hoods or glove boxes) and is not permitted if there is a reasonable likelihood of workers exceeding regulatory exposure limits. For questions regarding exposure limits and for assistance in conducting a hazard assessment for uncontained procedures, contact the EH&S Hotline at 310-825-9797.
2. Laboratories and rooms where particularly hazardous substances are used outside of containment systems must have general room ventilation that is maintained at negative pressure with respect to public areas. Air from these ventilation systems must be vented externally; recirculation is not permitted. Doors providing access from public areas must be kept closed.

F. Special Handling & Storage Requirements

1. Particularly hazardous substances must be stored in a designated area and used in a manner that will minimize the risk of accidental release (e.g., capped tightly, use of chemical resistant secondary containment, whenever possible). Laboratory personnel should remove chemicals from storage only as needed and return them to storage as soon as practical.
2. Chemicals should be segregated from incompatible materials, as described in the UCLA Chemical Hygiene Plan. The use of particularly hazardous substances must be confined to an established designated area (see C. Use in Designated Areas, above).
3. Additional requirements for the safe storage of a specific chemical may be found in the manufacturer's instructions or in the MSDS.
4. When transporting chemicals beyond the immediate laboratory environment, containers should be protected from breakage by using a bottle carrier or other effective containment.
5. Contact the EH&S Hotline at 310-825-9797 for guidance on the planned use of chemicals that may require further controls.

G. Spill & Accident Procedures

1. Immediate measures must be available to prevent the possible spread of contamination in the event of a small spill of a particularly hazardous substance. Absorbent materials and clean up materials should be available in all laboratories sufficient to contain and decontaminate individuals and equipment and areas. Any known spills must be contained and decontaminated as soon as possible.
2. In the event of a large spill that is beyond a laboratory group's immediate response capabilities, the following procedures should be followed:
   a. Evacuate the area immediately.
   b. Restrict access to the affected areas to emergency responders and post signage and barriers as needed to prevent unauthorized entry.

   c. Contact EH&S Hazmat immediately for response and remediation. Call 911 from a UCLA campus phone, or (310) 825-1491 from a cell phone (to UCPD) as needed.

3. In the event of direct skin contact with a particularly hazardous substance, the affected person must shower or flush the affected areas for a minimum of 15 minutes. Whenever personal contamination occurs, the event must be reported to EH&S at (310-825-9797) and an incident report will be completed and maintained by EH&S.
4. If the spill involves acutely toxic materials, the spill should be treated as a large spill if there is any doubt about the group's ability to safely mitigate the spill.
5. If the spill involves regulated carcinogens, a Report of Use may need to be filed (see J. Regulated Carcinogens and Report of Use Requirements, below).

H. Routine Decontamination Procedures

1. To limit the spread of contamination, laboratory work surfaces should be decontaminated at the conclusion of each procedure and at the end of each day on which particularly hazardous substances are used.
2. All equipment should be decontaminated before removing it from the designated area; this decontamination should be carried out in a glove box or fume hood where practical.
3. Contaminated PPE must not be removed from the designated area until properly decontaminated; refer to UCLA Policy 905 and the Chemical Hygiene Plan for guidance on the cleaning of protective apparel and other PPE. After working with these chemicals, gloves must immediately be removed and disposed of as hazardous waste and hands and arms washed with soap and water.

I. Waste Disposal Procedures

1. Disposal of waste materials that include particularly hazardous substances must comply with the hazardous chemical waste disposal procedures found in the Laboratory Safety Manual.
2. In addition to general hazardous waste labeling requirements, waste containers containing particularly hazardous substances must also be labeled as appropriate for the specific chemical hazard:

   "DANGER, CANCER HAZARD – SUSPECT AGENT"

   "DANGER, CANCER HAZARD – REGULATED CARCINOGEN"

   "DANGER, REPRODUCTIVE TOXIN"

   "DANGER, ACUTE TOXIN"

   Signage templates can be obtained from the UCLA Chemistry and Biochemistry safety webpage.
3. All non-radioactive chemical waste must be disposed of through the UCLA Hazardous Chemical Waste Program. Mixed wastes of hazardous chemicals and radioactive material are disposed of through the Radiation Safety Department. Due to regulatory restrictions and the high cost of disposal, the Radiation Safety Department should be contacted prior to producing mixed wastes.

J. Regulated Carcinogens and Report of Use Requirements

1. Regulated carcinogens are a specific subset of select carcinogens which have special additional requirements associated with their use under certain circumstances. See Attachment B for the specific list. EH&S maintains an air sampling program to monitor individuals to determine if they are, or may reasonably be expected to, exceed short or long term exposure limits. Every effort should be made to keep exposure levels below these limits by using fume hoods, limiting the quantities used, and following SOP designed to reduce exposure. If levels cannot be kept below these levels, additional requirements may include:
   - Required medical evaluations.
   - Additional documented training.
   - Use of respirators with required initial and ongoing training, medical evaluations, and maintenance documentation.

- Additional documented hazard evaluations.

2. Listed carcinogens are a further subset of regulated carcinogens. See Attachment C for the specific list. The use of these materials must be registered with EH&S through the Laboratory Hazard Assessment Tool or other equivalent EH&S approved process. An evaluation will be completed to assess safety requirements for groups that use these materials.

   Report of Use Requirements must be met for each group when they:

   - Begin the use of, or make significant changes to existing use of any listed carcinogen.
   - Use regulated carcinogens such that there is a reasonable expectation that exposure limits may be exceeded.
   - In the event of an emergency in which employees have been exposed to any regulated carcinogen.

VI. ATTACHMENTS

A. Particularly Hazardous Substances Definitions

B. Regulated Carcinogens

C. Listed Carcinogens

Issuing Officer

/s/ James S. Economou

Vice Chancellor for Research

Questions concerning this policy or procedure should be referred to the Responsible Department listed at the top of this document.

ATTACHMENT A

Particularly Hazardous Substances Definitions

Particularly hazardous substances fall into the following three major categories: acute toxins, reproductive toxins and carcinogens.

Acute Toxins

Substances that have a high degree of acute toxicity are substances that may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration. They can be defined as:

1. A chemical with a median lethal dose (LD50) of 50 mg or less per Kg of body weight when administered orally to albino rats weighing between 200 and 300 gm each;
2. A chemical with a median lethal dose (LD50) of 200 mg or less per Kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 Kg each; and
3. A chemical that has a median lethal concentration (LC50) in air of 5000 ppm by volume or less of gas or vapor, or 50 mg per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 gm each.

Reproductive Toxins

Reproductive toxins include any chemical that may affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis). A list of reproductive toxins is maintained online at http://www.oehha.ca.gov/prop65/prop65_list/Newlist.html#files.

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.

The term “regulated carcinogen” means a recognized cancer causing substance, compound, mixture, or product regulated by Cal/OSHA sections 1529, 1532, 1532.2, 1535, 8358, 8359 or Article 110, sections 5200-5220. *See Attachment B for the specific list of Regulated Carcinogens.*

The term “Listed Carcinogen” refers to a specific list of 13 chemicals regulated by Cal/OSHA and Federal OSHA and has specific use and handling requirements. *See Attachment C for the specific list of Listed Carcinogens.*

The term “select carcinogen” refers to a category of chemicals where the available evidence strongly indicates that the substances cause human carcinogenicity. A select carcinogen meets one of the following criteria:

1. It is regulated by Cal/OSHA as a carcinogen; or
2. It is listed under the category “known to be carcinogens” in the annual report by the National Toxicology Program (NTP); or
3. It is listed under Group 1 – “carcinogenic to humans” – by the International Agency for Research on Cancer (IARC); or
4. It is listed in either Group 2A or Group 2B by the IARC or under the category “reasonably anticipated to be carcinogens” by the NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
    a. 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;
    b. After repeated skin application of less than 300 mg/kg of body weight per week; or
    c. After oral dosages of less than 50 mg/kg of body weight per day.

ATTACHMENT B

Regulated Carcinogens

The term “regulated carcinogen” means a recognized cancer causing substance, compound, mixture, or product regulated by Cal/OSHA sections 1529, 1532, 1532.2, 1535, 8358, 8359 or Article 110, sections 5200-5220. For more information, see UCLA Policy 907.

- Acrylonitrile
- Arsenic metal and inorganic arsenic compounds
- Asbestos
- Benzene
- 1,3-butadiene
- Cadmium metal and cadmium compounds
- Chromium(VI) compounds
- Coke Oven Emissions
- 1,2-Dibromo-3-chloropropane (DBCP)
- Ethylene Dibromide (EDB)
- Ethylene Oxide (EtO)
- Formaldehyde gas and formaldehyde solutions
- Lead metal and inorganic lead compounds
- Methylene Chloride
- 4,4'-Methylene bis(2-chloroaniline) (MBOCA)
- Methylenedianiline (MDA)
- Vinyl Chloride
- 2-Acetylaminofluorene
- 4-Aminodiphenyl
- Benzidine (and its salts)
- 3,3'-Dichlorobenzidine(and its salts)
- 4-Dimethylaminoazobenzene
- alpha-Naphthylamine
- beta-Naphthylamine
- 4-Nitrobiphenyl
- N-Nitrosodimethylamine
- beta-Propiolactone
- bis-Chloromethyl ether
- Methyl chloromethyl ether
- Ethyleneimine

ATTACHMENT C

Listed Carcinogens

The term “listed carcinogen” refers to a specific list of 13 chemicals regulated by Cal/OSHA and Federal OSHA and has specific use and handling requirements. For more information, see UCLA Policy 907.

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

APPENDIX D: LABORATORY INSPECTION CHECKLIST[§]

[§] UCLA EH&S Laboratory Inspection Checklist can be accessed at: https://ucla.app.box.com/ehs-lab-inspection-checklist

Laboratory Safety
Laboratory Inspection Checklist

501 Westwood Plaza, 4th Floor • Los Angeles, CA 90095
Phone: 310-825-5689 • Fax: 310-825-7076 • www.ehs.ucla.edu

Date	

Lab Information	
Department	
Principal investigator (PI)	
PI telephone number	
PI email address	
Building	
Lab room numbers	
Lab Safety contact person	
Lab Safety contact telephone number	
Lab Safety contact email address	
Lab phone number	

☐	**Radiation**	☐	**Biosafety 2 or greater**	☐	**Lasers**	☐	**Animals**

Chemical Types Present			
☐	Particularly Hazardous Substances (select carcinogens, acute toxicants, reproductive toxicants)	☐	Flammables
☐	Regulated carcinogens	☐	Explosives
☐	Pyrophorics	☐	Peroxide Formers
☐	Water Reactives	☐	Corrosives

Explanation of Ratings
1: Compliant • 0: Non compliant/not acceptable • N/A: Not applicable • *Denotes Administrative Deficiency
S: Serious finding that must be corrected within 48 hours or less, depending on severity of finding.

Personnel Information		
First Name	**Last Name**	**UID**

Explanation of Ratings
1: Compliant • 0: Non compliant/not acceptable • N/A: Not applicable • *Denotes Administrative Deficiency
S: Serious finding that must be corrected within 48 hours or less, depending on severity of finding.

Inspection Information	
Inspector	
Inspector email address	
Accompanied by	

Documentation & Training

1	0	S	N/A	Inspected	Comments
☐	☐		☐	Current Lab Safety Manual is accessible. CHP should be read and understood. Training documented with signature and date.	
☐	☐		☐	Current Lab Hazard Assessment Tool (LHAT) updated, signed and located inside Lab Safety Manual	
☐	☐		☐	Initial and/or refresher EH&S Safety training documented	
☐	☐		☐	Lab Site Safety Orientation complete, documented and located inside Lab Safety Manual	
☐	☐		☐	Lab Specific Safety training documented and sufficient to cover lab operations	
☐	☐		☐	Initial and annual training for respirator users	
☐	☐		☐	Documented Fire Extinguisher Training	
☐	☐		☐	Laboratory accidents documented	

Hazard Communication

1	0	S	N/A	Inspected	Comments
☐		☐	☐	SDS accessible (i.e., hard copy or on-line). Location known to all lab personnel.	
☐	☐		☐	SOP available (experiment/equipment/ hazardous activity). Should be signed by the PI and respective users.	
☐	☐		☐	Containers labeled with contents (full name, hazard warning, and date; no conflicting labels)	
☐	☐		☐	Current chemical inventory accessible	
☐	☐		☐	Chemical storage cabinets labeled (i.e., corrosives, flammables, etc…)	

Explanation of Ratings
1: Compliant • 0: Non compliant/not acceptable • N/A: Not applicable • *Denotes Administrative Deficiency
S: Serious finding that must be corrected within 48 hours or less, depending on severity of finding.

Emergency & Safety Information					
1	0	S	N/A	Inspected	Comments
☐		☐	☐	Emergency assistance and 1,2,3 posters accessible in lab	
☐	☐		☐	NFPA fire diamond posted	
☐	☐		☐	NFPA fire diamond updated with current occupants & emergency contacts	

Fire Safety					
1	0	S	N/A	Inspected	Comments
☐	☐		☐	Storage clearance from ceiling: 18" with sprinklers, 24" without sprinklers	
☐		☐	☐	Fire extinguisher present/charged/accessible	
☐	☐		☐	Fire extinguisher tag updated; signage clearly visible	

General Safety					
1	0	S	N/A	Inspected	Comments
☐	☐		☐	Exits/aisles/corridors are not blocked (24" minimum width)	
☐	☐		☐	Laboratory doors kept closed	
☐		☐	☐	Approved safety shower & eyewash station accessible within 10 seconds (travel distance no greater than 100 feet)	
☐	☐		☐	Emergency shower / Eyewash Station inspected monthly	
☐		☐	☐	Clearance area around safety shower at least 16" in each direction. Signage clearly visible.	
☐	☐		☐	First-aid kit present, stocked and without expired products	
☐	☐		☐	Chemical spill material or kit available, spill procedures known to staff. Chemical spill kit should include necessary neutralizers.	
☐	☐		☐	Gas cylinders secured upright with double chains to a stable structure (i.e., wall or with clam shell/frame casing.)	

Explanation of Ratings
1: Compliant • 0: Non compliant/not acceptable • N/A: Not applicable • *Denotes Administrative Deficiency
S: Serious finding that must be corrected within 48 hours or less, depending on severity of finding.

General Safety

1	0	S	N/A	Inspected	Comments
☐	☐		☐	Gas cylinder valve protection cap in place when not in use	
☐	☐		☐	Refrigerators/freezers labeled with food and drink specifications	
☐	☐		☐	Sink available for hand washing	
☐	☐		☐	Engineering controls functional	

Personal Protective Equipment (PPE)

1	0	S	N/A	Inspected	Comments
☐		☐	☐	Closed-toe shoes and long pants worn by laboratory personnel as required by campus PPE policy 905	
☐		☐	☐	Lab coats worn as required by campus PPE policy 905	
☐		☐	☐	Gloves worn as required by campus PPE policy 905	
☐		☐	☐	Eye protection worn as required by campus PPE policy 905 (Goggles must be worn for procedures involving chemical splashes)	
☐	☐		☐	Adequate supply of specialty PPE available (i.e. UV/IR glasses, face shields, lab aprons, cryogenic gloves)	
☐	☐		☐	PPE contaminated with extremely hazardous materials disposed of as Haz Waste	

Housekeeping

1	0	S	N/A	Inspected	Comments
☐		☐	☐	No food or drink in lab areas	
☐		☐	☐	Secondary containment provided for floor storage of glass bottles that contain chemicals.	
☐	☐		☐	Minimal glassware on bench top	
☐	☐		☐	Minimal glassware in sink	
☐	☐		☐	Minimal glassware in fume hood	
☐	☐		☐	Proper waste disposal of sharps (broken glass, pipettes, needles, razors, etc)	

Explanation of Ratings
1: Compliant • 0: Non compliant/not acceptable • N/A: Not applicable • *Denotes Administrative Deficiency
S: Serious finding that must be corrected within 48 hours or less, depending on severity of finding.

Housekeeping

1	0	S	N/A	Inspected	Comments
				Sharps containers less than ¾ full	

Chemical Storage and Compatibility

1	0	S	N/A	Inspected	Comments
				Less than 10 gallons of flammables located outside flammable storage cabinet	
				Maximum of 60 gallons flammable liquids per flammable storage cabinet, maximum of 3 flammable storage cabinets per lab/fire area.	
				Flammable storage refrigerator/freezer approved and labeled	
				Minimal acids stored outside corrosive cabinet	
				Strong acids and strong bases stored in secondary containers	
				Incompatible materials properly segregated	
				Chemicals stored safely (e.g. seismic restraints, etc.)	
				Combustible materials not stored with flammable chemicals	
				Chemical containers in good condition	
				Corrosive chemicals stored below eye level	
				Ethers and other peroxide formers dated	
				Water reactive chemicals segregated, contained, and labeled	
				Carcinogens segregated and stored in designated areas.	
				Pyrophoric chemicals segregated, contained, and labeled	

Fume Hoods

1	0	S	N/A	Inspected	Comments
				Certified within one year	

Explanation of Ratings
1: Compliant • 0: Non compliant/not acceptable • N/A: Not applicable • *Denotes Administrative Deficiency
S: Serious finding that must be corrected within 48 hours or less, depending on severity of finding.

Fume Hoods

1	0	S	N/A	Inspected	Comments
☐	☐		☐	Proper sash height indicated	
☐	☐		☐	Sash at or below marked approval level	
☐	☐		☐	Sash stoppers functional where present	
☐	☐		☐	Hood illumination functional	
☐	☐		☐	Audible/visual alarm functional	
☐		☐	☐	Minimal clutter in hood (equipment, chemicals)	
☐	☐		☐	Functional fume hood not used for storage	

Biosafety Cabinets

1	0	S	N/A	Inspected	Comments
☐	☐		☐	Certified within one year	

Chemical Waste Disposal and Transport

1	0	S	N/A	Inspected	Comments
☐	☐		☐	Safety cans available and labeled for disposal of solvents	
☐	☐		☐	Containers available and labeled for disposal of hazardous waste	
☐	☐		☐	Content Section of waste tag be filled with full names. No abbreviations or formulas.	
☐		☐	☐	Waste tags attached to waste cans, containers	
☐	☐		☐	Chemical waste containers in good condition and kept closed (i.e. no funnels in place)	
☐	☐		☐	Sturdy cart available for transport of hazardous waste as needed	
☐	☐		☐	Hazardous waste in secondary containment	
☐	☐		☐	Designated hazardous waste storage areas	

Explanation of Ratings
1: Compliant • 0: Non compliant/not acceptable • N/A: Not applicable • *Denotes Administrative Deficiency
S: Serious finding that must be corrected within 48 hours or less, depending on severity of finding.

Chemical Waste Disposal and Transport					
1	0	S	N/A	Inspected	Comments
☐	☐		☐	Chemical waste disposed when full or within 90 days, whichever is sooner	
☐	☐		☐	Dry hazardous waste double-bagged in transparent bags	
☐	☐		☐	Hazardous chemicals/materials not found in regular trash.	

Seismic Safety					
1	0	S	N/A	Inspected	Comments
☐	☐		☐	Shelving and file cabinets 5' or over anchored/bolted	
☐	☐		☐	Storage shelves have seismic restraints (e.g. lips, bars, bungee cords)	
☐	☐		☐	High overhead storage is secured	
☐	☐		☐	Heavy items stored on lower shelves	

Mechanical and Electrical Safety					
1	0	S	N/A	Inspected	Comments
☐	☐		☐	Moveable parts guarded on equipment as appropriate	
☐	☐		☐	Electrical panel accessible	
☐	☐		☐	Nothing posted on electrical panel	
☐		☐	☐	Plugs, cords, outlets in good condition	
☐		☐	☐	No overloaded outlets, no daisy-chained power strips	
☐	☐		☐	Extension cords only present for immediate use and do not pose trip hazards (i.e., taped down, covered)	
☐	☐		☐	Power strips secured off the floor and away from liquids	
☐	☐		☐	No power cords found under doors, carpets, or through ceilings	

Explanation of Ratings
1: Compliant • 0: Non compliant/not acceptable • N/A: Not applicable • *Denotes Administrative Deficiency
S: Serious finding that must be corrected within 48 hours or less, depending on severity of finding.

APPENDIX E: NANOTOOLKIT**

** California Nanosafety Consortium of Higher Education Nanotoolkit can be accessed: http://innovation.luskin.ucla.edu/content/nanotoolkit-working-safely-engineered-nanomaterials-academic-research-settings

Best practices, Standards, and Guidelines to using engineered nanomaterials.

Nanotoolkit

Working Safely with Engineered Nanomaterials in Academic Research Settings

California Nanosafety Consortium of Higher Education
04/19/2012

Acknowledgement

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Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation, the Environmental Protection Agency, the California Department of Toxic Substances Control, or the UCLA Luskin Center. This work has not been subjected to EPA review and no official endorsement should be inferred.

Editor

Janette de la Rosa Ducut, Ed.D. *University of California Riverside*

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Preface

Background on California Nanosafety Consortium of Higher Education and Development of the Nanotoolkit

Background

The increasing use of nanomaterials in research and development laboratories along with applications in industry are providing breakthroughs for many technologies and solutions for addressing major problems in our society. However, as with all new technologies, the potential health effects of engineered nanomaterials (ENMs) remain uncertain. The aim of this project is to provide practical guidance as to how ENMs should be handled safely in the research laboratory setting in the face of such uncertainty over possible toxic effects.

Currently many government agencies, academic institutions, and industries have issued detailed guidance documents as to how NMs should be monitored, controlled, and handled in different work settings. Only a portion of these practices have been validated by scientific research or reference to peer reviewed literature. Most guidance documents and exposure studies to date have focused primarily on industrial settings, but academic research settings present their own challenges that also need to be addressed. Much of the initial research and development (R&D) in nanotechnology is still performed in academic research laboratories. In academic laboratories, the quantity of materials used tends to be less than those used in industry, but the variety of nanomaterials used tends to be more diverse. As a result, the potential hazards are also more diverse and exposure monitoring is more challenging. Furthermore, academic practices tend to be less standardized and to vary more from lab to lab and from day to day than typical industrial processes. This means that engineering controls which are commonly used in industry may not be practical to apply in academic laboratory research settings.

The nature of research and training in academic institutions dictates that new students and employees with various backgrounds and levels of training are regularly being introduced into the many diverse laboratory settings. Undergraduate student researchers, graduate students and other laboratory personnel often have minimal formal safety training or are lacking the latest hazard information about such new technological developments. All of these factors make a simple adoption or application of standardized industrial best practices for working with NMs in laboratories difficult.

Goals

The goal of this project is to provide an easy to use tool kit for academic researchers to quickly identify safe handling practices based on whether the work they propose is in a low, moderate, or high potential exposure category. The exposure categories and controls were determined from a review and analysis of many related nanomaterial health and safety guidance documents.

Methods

The analysis of the proposed recommendations included summarizing all the relevant recommendations from the various guidance documents into one matrix, conducting a literature search to see if the recommended practices were appropriately validated, and having a group of experienced environmental health and safety professionals from various California universities use their professional judgment and the research literature provided to rank the applicability of each recommendation as well as rate each recommendation in terms of the need for further research.

The working group summarized documents from 19 academic institutions, 14 government agencies and four industrial sources. This project was a collaborative effort by the California Nanosafety Consortium of Higher Education. The group included representatives from:

Government Agencies

National Institute of Occupational Safety and Health (NIOSH)
Department of Toxic Substances Control (DTSC)

University Environmental Health and Safety Professionals (EH&S)

University of California Los Angeles (UCLA)
University of California Irvine (UCI)
University of California Riverside (UCR)
University of California (UC) Office of the President
University of Southern California (USC)
Stanford University
California Institute of Technology
Claremont University Consortium

In addition, the project involved professor(s) and graduate students from the University of California Los Angeles (UCLA) and University of California Santa Barbara (UCSB).

Through this process we identified existing safety concerns of health and safety professionals and uncovered shortcomings in the current guidance documents, while recommending guidance that is most appropriate and validated by peer reviewed research for application to the research laboratory setting. A practical and easy to use tool kit was developed to help academic researchers to quickly identify proposed laboratory research work with nanomaterials as a low, medium, or high-risk activity and then identify appropriate control measures. Also included are sections with general information about engineered nanomaterials, spill cleanup and waste management.

The user of this tool kit is advised that this document provides a best practice guideline to approaching and understanding how to work safely with engineered nanomaterials in the laboratory. Ultimately, it is the responsibility of the faculty member, the principal investigator, or the laboratory supervisor who is directing such work in the laboratory to provide for the safe conduct of all individuals conducting research in their laboratories. If applied diligently and appropriately, these guidelines will help provide for the safety and health of laboratory personnel conducting research using engineered nanomaterials.

Using the Nanotoolkit

What is the Nanotoolkit?

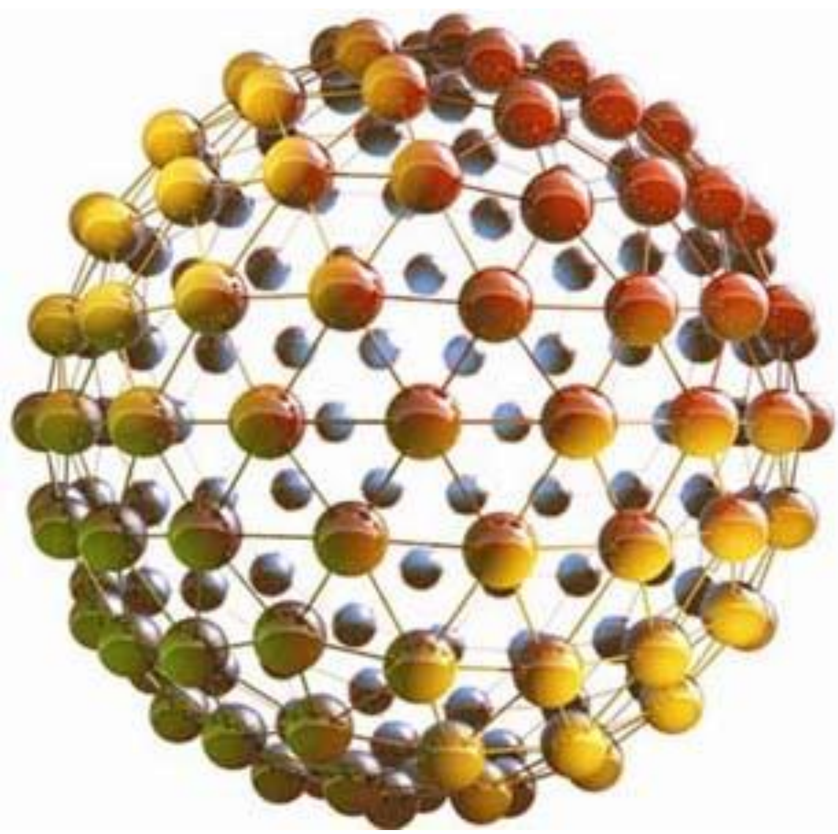
The Nanotoolkit is an easy to use guide for academic researchers to quickly identify safe handling practices when working with Engineered Nanomaterials (ENMs) based on a low, moderate, or high potential exposure category as described in this document.

How to Use:

1. Read the ***Overview of Nanomaterials*** section to obtain general information on ENMs.

2. Review the ***Planning Your Research*** and ***Conducting Your Research*** sections to obtain information on how to plan and conduct your experiment/operation involving ENMs.

3. Use the ***Quick Guide: Risk Levels and Control Measures for Nanomaterials*** to prepare a Standard Operating Procedure (SOP) for your experiment/operation employing the template provided.



Overview of Nanomaterials

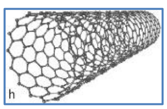
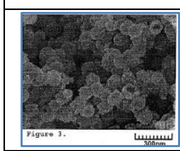
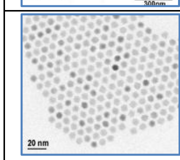
Definitions

Nanomaterial: Material or particle with any external dimension in the nanoscale (range 1 nm to 100 nm) or having internal structure or surface structure in the nanoscale (Source: ISO/TS 80004-1:2010, ISO/TS 27687:2008)[1, 2]

Naturally Occurring Nanomaterial: Particles on the nanoscale occur naturally in the environment. They can also be manufactured and have a variety of commercial applications. More information on naturally occurring nanomaterials can be found in Appendix C.

Engineered Nanomaterials (ENMs): An Engineered Nanomaterial is any intentionally produced material with any external dimension in the nanoscale. It is noted that neither 1 nm nor 100 nm is a "bright line" and some materials are considered engineered nanomaterials that fall outside this range. For example, Buckyballs are also included even though they have a size <1 nm. Excluded are materials that are on the nanoscale, but do not have properties that differ from their bulk counterpart and micelles and single polymers.[3]

Types of Nanomaterials

	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[10] of TWA 7 $\mu g/m^3$ due to the risk of developing respiratory health effects.

**Nano-Titanium Dioxide is subject to a proposed Permissible Exposure Limit[11] of TWA 0.3 mg/m^3 due to the risk of developing lung cancer. There are mixed studies regarding TiO2 skin penetration. Some studies indicate TiO2 and ZnO does not pass through the stratum corneum[6,7], while others indicate significant penetration through the skin[8].

Occupational Health and Safety Concerns

1. **Routes of Exposure**
   Exposure to engineered nanomaterials may occur via inhalation and dermal contact depending on use and handling; ingestion is unlikely but possible.
2. **Lack of Information on Full Health Effects**
   With a lack of chronic exposure data and reproductive and developmental toxicity data, a precautionary approach when working with engineered nanomaterials is warranted.
3. **Toxicity**
   Some potential toxic outcomes can be predicted from what we know about ultrafine particles[4] and based on known chemical and structural properties[5]. Nanomaterials have the potential to:
   1. *Deposit in the respiratory tract*. Small airborne particles penetrate deep into the lungs.
   2. *Cross cell membranes*. Some nanomaterials have the ability to cross cell membranes.
   3. *Penetrate healthy intact skin/translocation to other organ systems.* Reports on this topic are mixed; caution is urged until more is known.

4. **Other**
   a. **Catalytic effects**. In general, nanomaterials are not known to have catalytic effects, however, some nanomaterials are specifically engineered to have catalytic properties.
   b. **Fire or explosion**. Nanomaterials are generally not explosive or flammable in small laboratory quantities unless the material is inherently reactive, however some of the synthesis methods may use techniques where fire and explosion are potential hazards.

Exposure Limits

Nanomaterials fall under OSHA General Industry Standards[9]. Established exposure limits for naturally occurring nanomaterials, and detailed information about current state and federal regulations can be found in Appendix C. **Although there are currently no established (legal) exposure limits (US or International)** for Engineered Nanomaterials, NIOSH has developed Recommended Exposure Limits (RELs) for carbon nanotubes (TWA 7 µg/m^3) and nano-titanium dioxide (TWA 0.3 mg/m^3).

Planning your research

1. Gather Information

Select less-hazardous forms. Whenever possible, select engineered nanomaterials bound in a substrate or matrix or in water-based liquid suspensions or gels.

Review Material Safety Data Sheet (MSDS), if available.

NOTE: Information contained in some MSDSs may not be fully accurate and/or may be more relevant to the properties of the bulk material rather than the nano-size particles. The toxicity of the nanomaterials may be greater than the parent compound.

Review your institution's Chemical Hygiene Plan for general laboratory safety guidance.

2. Determine Potential Risks

Common laboratory operations involving ENMs may be categorized as posing a low, moderate, or high potential exposure risk to researchers depending on the state of the material and the conditions of use. Refer to the ***Quick Guide: Risk Levels and Control Measures for Nanomaterials***. Follow the instructions in this matrix to identify the potential risk of exposure and recommended control measures. Special consideration should be given to the high reactivity of some nanopowders with regard to potential fire and explosion, particularly if scaling up the process. Consider the hazards of the precursor materials in evaluating the process.

3. Develop a Standard Operating Procedure (SOP)

A standard operating procedure (SOP) is a set of written instructions that describes in detail how to perform a laboratory process or experiment safely and effectively. Employing the hierarchy of controls described in ***Quick Guide: Risk Levels and Control Measures for Nanomaterials***, establish an SOP for operations involving nanomaterials. For an example, refer to Appendix B.

4. Obtain Training and Consultation / Approval

Training. Principal Investigators or laboratory supervisors must ensure that researchers have both general laboratory safety training pursuant to Cal/OSHA's *Occupational Exposure to Hazardous Chemicals in Laboratories* (8 CCR 5191) and lab-specific training relevant to the nanomaterials and associated hazardous chemicals used in the process/experiment. Laboratory-specific training can include a review of this Nanotoolkit, the relevant Material Safety Data Sheets (if available), and the lab's Standard Operating Procedure (SOP) for the experiment.

Consultation / Approval. Consult with and seek prior approval of the Principal Investigator or laboratory supervisor prior to procuring or working with nanomaterials, and/or if working alone in the laboratory is anticipated. [Follow institution's rules on working alone.]

Notification. If dosing animals with the nanomaterial, follow institution's hazard communication processes for advanced notification of animal facility and cage labeling/management requirements.

Controlling potential exposures to nanomaterials involves elimination of highly hazardous materials through substitution, engineering controls, administrative or work practices, and personal protective equipment. The hierarchy of controls are shown in Figure 1. If the nanomaterial cannot be substituted with a less hazardous substance, then engineering controls must be installed to control exposure.

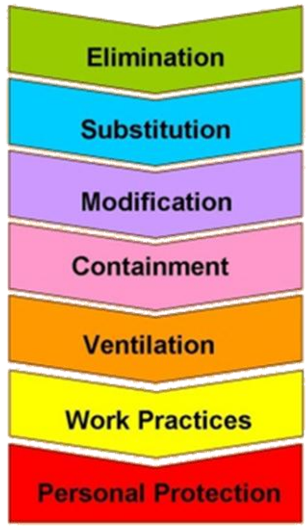


Figure 1
Hierarchy of Controls

1. Minimize Exposures

Engineering Controls

CONTROL EXPOSURE WITH EQUIPMENT

Minimize airborne release of ENMs by utilizing one of the following devices:

Work in a laboratory fume hood or biosafety cabinet. Conduct work inside a fume hood or low flow enclosures to prevent exposure. Biosafety cabinets must be ducted if used in conjunction with volatile compounds.

Use a glove box or fully-enclosed system. Where it is not possible to prevent airborne release, such as in grinding operations or in gas phase, use equipment that fully encloses the process. This includes a glove box.

Use local capture exhaust hoods. Do not exhaust aerosols containing engineered nanoparticles into the interior of buildings. Use High-Efficiency Particulate Air (HEPA) filtered local exhaust ventilation (LEV). HEPA-filtered LEV should be located as close to the possible source of nanoparticles as possible, and the installation must be properly engineered to maintain adequate ventilation capture. Use HEPA-filtered local capture exhaust hoods to capture any nanoparticles from tube furnaces, or chemical reaction vessels or during filter replacements.

ENSURE PERFORMANCE AND MAINTENANCE

Laboratory equipment and exhaust systems used with nanoscale materials should be wet wiped and HEPA vacuumed prior to repair, disposal, or reuse. Make sure fume hoods and any LEV achieves and maintains adequate control of exposure at all times. These systems require regular maintenance and periodic monitoring to ensure controls are working and thorough examination and testing at least once a year.

Administrative Controls

USE SOLUTIONS OR SUBSTRATES

To minimize airborne release of engineered nanomaterials to the environment, nanomaterials are to be handled in solutions, or attached to substrates so that dry material is not released.

LOCATE SAFETY EQUIPMENT

Know the location and proper use of emergency equipment, such as emergency eyewash/safety showers, fire extinguishers, fire alarms, and spill clean-up kits[12].

USE SIGNS AND LABELS

Restrict access and post signs in area indicating ENM work. When leaving operations unattended, use cautious judgment: 1) Post signs to communicate appropriate warnings and precautions, 2) Anticipate potential equipment and facility failures, and 3) Provide appropriate containment for accidental release of hazardous chemicals.

CLEAN AND MAINTAIN

Line work area with absorbent pad. When working with powders, use antistatic paper and floor sticky mats. Wet wipe and/or HEPA-vacuum work surfaces potentially contaminated with nanoparticles (*e.g.*, benches, glassware, apparatus) at the end of each operation. Consult with your institution regarding the maintenance of HEPA vacuums and replacement of HEPA filters.

MAINTAIN PERSONAL HYGIENE

To avoid potential nanoparticle or chemical exposure via ingestion in area where ENMs are used or stored, do not: consume or store food and beverages, apply cosmetics, or use mouth suction for pipetting or siphoning. Remove gloves when leaving the laboratory in order to prevent contamination of doorknobs or other common use objects such as phones, multiuser computers, etc. Wash hands frequently to minimize potential chemical or nanoparticle exposure through ingestion and dermal contact.

STORE AND LABEL PROPERLY

Store nanomaterials in a well-sealed container. Label all chemical containers with the identity of the contents (do not use abbreviations/ acronyms); include term “nano” in descriptor (*e.g.*, “nano-zinc oxide particles” rather than just “zinc oxide.” Include hazard warning and chemical concentration information, if known.

TRANSPORT IN SECONDARY CONTAINMENT

Use sealed container with secondary containment when transporting nanomaterials between laboratories or buildings.

Table 1. Glove Choices for Nanomaterials

Select glove based on compatibility with material and solvents to be used and, if possible, permeability studies for that category of ENM. Recommend wearing gauntlet-type/wrist-length gloves with extended sleeves. The table below contains information on select ENMs and the associated reference.

Nanomaterial / State	Glove Type (Recommendation)
Carbon Nanotubes (CNTs)	Nitrile over Latex*, **
TiO_2 and PT	Latex**, Nitrile, Neoprene***
Graphite	Latex**, Nitrile, Neoprene, Vinyl***

* Consider potential latex allergies in PPE selection.
**Reference: Methner, et. al (NIOSH)
*** Reference: Golanski, et. al (2010)

Personal Protective Equipment (PPE)

Know the Applications and Limits

The use of PPE is generally considered to be the least desirable option to control employee exposure to occupational safety and health hazards. However, in an academic laboratory, there are often scenarios under which PPE can minimize potential employee exposure to occupational safety and health hazards either as a stand-alone control mechanism, or, as a supplement to either administrative or engineering control approaches.

Many occupational safety and health issues associated with ENM's are not fully understood (*i.e.*, ENM toxicity, exposure metrics, fate and transport, etc.). The same uncertainty exists with how to select the myriad of available types of PPE and effectively use them to minimize the potential hazards associated with employee exposure to ENM hazards.

The use of PPE is considered to be the least desirable option to control employee exposure.

There is a growing body of evidence resulting from on-going research which indicates that commonly available PPE does have efficacy against specific sizes and types of ENMs. The PPE described within the Nanotool Quick Guide was selected as a result of a comprehensive review of available guidance and published research available at the time the Guide was developed.

Use the Quick Guide

The user of this Nanotool is directed to the Quick Guide for a description of the recommended PPE. Note that the referenced PPE increases for each Category consistent with the increasing exposure potential. The basic PPE ensemble described under **Category 1** is to be augmented by the specific PPE in **Category 2** and **Category 3**. The user is reminded of the following important issues associated with the safe and effective use of PPE:

- *Respiratory Protection.* Mandatory use of respirators will require full adherence to the requirements of your institution's respiratory protection program. It is imperative that you consult with your institution's EH&S representative prior to utilizing respiratory protection, even if that use is voluntary.

- *Gloves and Clothing.* Glove material, fabrication process and thickness are significant issues which impact the permeation of ENM's. Consequently, consideration should be given to utilizing two layers of gloves. For more information, refer to Table 1.

The selection of dermal PPE for protection against ENM's must also take into account other chemicals which may be part of the ENM matrix or use conditions (*i.e.*, solvents, surfactants, carrier gases, etc.). Dermal PPE manufacturers provide permeation/penetration tables which allow the end user to select dermal PPE based upon performance criteria to specific chemical threats. For examples, refer to the Controlled Environments guide by Du Pont®, or the Chemical Resistance Guide by Ansell © 2003. The technique used to remove gloves (and all PPE) is very important so that any material contaminating the outer surfaces of the PPE does not impact the wearer. Consult with your EH&S representative to learn the appropriate technique(s) to remove chemical protective clothing.

Reduce PPE Hazards

Under specific use conditions, utilizing PPE may put the user at risk of occupational injury. PPE may impair vision and dexterity and increase the likelihood of trip, slip, or fall hazards in addition to increasing the potential to develop heat-related illnesses. Consult with your EH&S professional for questions pertaining to the appropriate selection and use conditions for PPE.

2. Respond to Exposures and Spills

Actions to be taken in the event of a personnel exposure or a spill exposure are listed as part of the Appendix A "Standard Operating Procedure (SOP)" template.

3. Dispose Properly

Manage waste streams containing ENMs according to the hazardous waste program requirements at your institution. Until more information is available, assume ENM containing wastes to be hazardous waste unless they are known to be non-hazardous (for more information, refer to the *Defining Hazardous Waste* guidance published by the Department of Toxic Substances Control). Recommended management methods for typical research waste streams containing nanomaterials are described in Table 2.

Table 2. Recommended Nanomaterial waste management methods by stream.

Waste Stream	Management Method
Solid • Dry ENM product • Filter media containing ENMs • Debris / dust from ENMs bound in matrix	1. Follow *General Nanomaterial Waste Management Practices* 2. Collect waste in rigid container with tight fitting lid.
Liquid • Suspensions containing ENMs	1. Follow *General Nanomaterial Waste Management Practices*. 2. Indicate both the chemical constituents of the solution and their hazard characteristics, and the identity and approximate percentage of ENMs on container labels. 3. Use leak proof containers that are compatible with all contents. 4. Place liquid waste containers in secondary containment and segregate from incompatible chemicals during storage.
Laboratory trash with trace nanomaterials • PPE • Tacki mats • Spill clean-up materials	1. Follow *General Nanomaterial Waste Management Practices*. 2. Dispose of in double clear plastic bags, folded over and taped at the neck. 3. Avoid rupturing the bags during storage and transport.
Solid Matrix embedded with nanomaterials (intact and in good condition)	1. Consult with your EH&S department, as these materials may be non-hazardous.

General Nanomaterial Waste Management Practices

1. **Manage according to** hazardous waste program requirements at your institution.
2. **Label nanomaterial waste containers** at all times. Specify the nanomaterial and its hazard characteristic (or the hazard characteristic of the parent material) on container labels; label information to contain the word "nano" as a descriptor.
3. **Keep containers closed** at all times when not in use.
4. Maintain containers in **good condition** and free of exterior contamination.

Quick Guide

Risk Levels and Control Measures for Nanomaterials

Purpose

This Quick Guide categorizes common laboratory operations involving engineered nanomaterials according to their potential risk of exposure to personnel, which is based on the state of the material and the conditions of use. Controls are provided in the table to minimize exposures. This guide is intended to be used in conjunction with the academic institutions' laboratory safety practices or other established guidelines (e.g., *Prudent Practices* by The National Research Council).

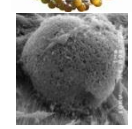
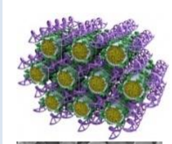
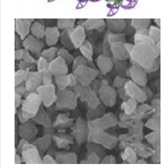
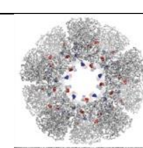
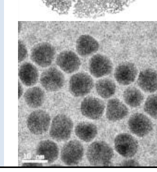
Instructions

Follow these steps to create a Standard Operating Procedure:

Step 1. Determine your risk level
Step 2. Identify the controls needed
Step 3. Develop a Standard Operating Procedure

Below are tables to assist you in completing each step. If your research falls in between two risk categories, consider employing the higher level control.

Step 1. Determine your risk level

Risk Level	Material State or Type of Use *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	 

Step 2. Identify the controls needed

Use the table below to identify the controls needed to work with the risk level of your nanomaterial (Category 1, 2, or 3).

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

Step 3. Develop a Standard Operating Procedure

Complete Appendix A "Standard Operating Procedures (SOP) for the Laboratory Use of Engineered Nanomaterials". For examples, refer to Appendix B.

Standard Operating Procedures (SOP)

For the Laboratory Use of Engineered Nanomaterials

Instructions: Review the ***Quick Guide: Risk Levels and Control Measures for Nanomaterials***. Use this template to develop a Standard Operating Procedure for your experiment / process.

OVERVIEW

PROCEDURE TITLE:		
DATE OF CREATION / REVISION:		
LOCATION: *(Building, Room #)*		
PRINCIPAL INVESTIGATOR (PI) OR LABORATORY SUPERVISOR NAME:	PHONE:	EMAIL:
DESCRIPTION. PROVIDE A 1-2 SENTENCE BRIEF DESCRIPTION OF THE PROCESS. INDICATE IF AEROSOLS ARE LIKELY TO BE CREATED.		
MATERIAL STATE AND CONDITIONS OF USE **Nanomaterials are handled in/as:** ☐ **DRY PARTICLES** (POWDERS / PELLETS) ☐ **SUSPENSION / GELS** ☐ **GASEOUS PHASE**	FREQUENCY (check one): ☐ **ONE TIME** ☐ **DAILY** ☐ **WEEKLY** ☐ **MONTHLY** ☐ **OTHER:**	DURATION PER EXPERIMENT: ___________ MINUTES; OR _________ HOURS

HAZARDS

RISK LEVEL: ☐ **CATEGORY 1**: LOW POTENTIAL FOR EXPOSURE ☐ **CATEGORY 2**: MODERATE POTENTIAL FOR EXPOSURE ☐ **CATEGORY 3**: HIGH POTENTIAL FOR EXPOSURE
POTENTIAL HAZARDS. IDENTIFY POTENTIAL CHEMICAL AND SAFETY HAZARDS USING THE MATERIAL SAFETY DATA SHEET (MSDS) FOR THE NANOMATERIAL OR PARENT COMPOUND. THE TOXICITY OF THE NANOMATERIALS MAY BE GREATER THAN THE PARENT COMPOUND. SPECIAL CONSIDERATION SHOULD BE GIVEN TO THE HIGH REACTIVITY OF SOME NANOPOWDERS WITH REGARD TO POTENTIAL FIRE AND EXPLOSION, PARTICULARLY IF SCALING UP THE PROCESS. CONSIDER THE HAZARDS OF ANY PRECURSOR MATERIALS IN EVALUATING THE PROCESS. FOR MORE INFORMATION, REFER TO THE SECTION ON "PLANNING YOUR RESEARCH".

INSTRUCTIONS: INDICATE THE ENGINEERING, WORK PRACTICE, AND PERSONAL PROTECTIVE EQUIPMENT (PPE) CONTROLS YOU WILL BE IMPLEMENTING TO REDUCE THE HAZARDOUS EFFECTS OF WORKING WITH YOUR NANOMATERIALS. BASE YOUR SELECTION ACCORDING TO THE "QUICK GUIDE" SECTION.

CONTROLS

ENGINEERING CONTROLS. INDICATE ENGINEERING DEVICE(S) TO BE UTILIZED. NOTE: IF WORK CANNOT BE CONDUCTED WITH APPROPRIATE ENGINEERING CONTROLS, CONSULT WITH AN EH&S PROFESSIONAL.

- ☐ **FUME HOOD** *(laboratory-type)*
- ☐ **BIOSAFETY CABINET** *(must be ducted if used in conjunction with volatile compounds)*
- ☐ **ENCLOSED SYSTEM** *(i.e., glove box, glove bag, or sealed chamber)*
- ☐ **POWDER HANDLING ENCLOSURE**
- ☐ **OTHER:**

WORK PRACTICE CONTROLS. THE FOLLOWING CONTROLS WILL BE IMPLEMENTED *(check all that apply):*

☐ Category 1 work practices

- **STORE** in sealed container with secondary containment with other compatible chemicals
- **LABEL** chemical container with the identity of contents and include term "nano" as descriptor
- **TRANSFER** in sealed container with secondary containment
- **PREPARE** work space by lining with absorbent materials
- **CLEAN** all surfaces potentially contaminated with nanoparticles (e.g., benches, glassware, apparatus) at the end of each operation using a HEPA vacuum and/or wet wiping methods.
- **WASH** hands frequently. Upon leaving the nanomaterial work area, remove any PPE worn and wash hands, forearms, face, and neck.
- **NOTIFY** in advance of animal facility and cage labeling / management requirements if dosing animals with nanomaterial

☐ Category 2 work practices

- **FOLLOW** all work practices listed for Category 1.
- **RESTRICT ACCESS.**
- **POST** signs in area
- **USE** antistatic paper and/or sticky mats with powders.

☐ Category 3 work practices

- **FOLLOW** all work practices listed for Category 2.

☐ **Approvals Required.**. IDENTIFY TASKS THAT REQUIRE PRIOR APPROVAL BY THE PRINCIPAL INVESTIGATOR / LABORATORY SUPERVISOR BEFORE PERFORMING:

☐ **Other**. DESCRIBE ANY ADDITIONAL WORK PRACTICES SPECIFIC TO THE EXPERIMENT / PROCESS:

PERSONAL PROTECTIVE EQUIPMENT (PPE). INDICATE THE PPE TO BE UTILIZED *(check all that apply):*

Body Protection:	☐ Long pants (no cuffs) ☐ Laboratory coat *made of standard materials* ☐ Laboratory coat *made of non-woven fabrics with elastics at wrists (i.e., Tyvek®)* ☐ Coveralls (disposable) with head coverage *(i.e., Tyvek®)*
Eye / Face Protection:	☐ Safety glasses with side shields ☐ Chemical splash goggles ☐ Face shield
Hand Protection:	☐ Latex ☐ Nitrile ☐ Neoprene ☐ Vinyl ☐ Other:
Foot Protection:	☐ Closed toe shoes ☐ Over-the-shoe booties
Other:	☐ Respiratory Protection* ☐ Other:

* Consult with your institution on respiratory program requirements

ACCIDENT AND SPILL PROCEDURES

LOCATION OF NEAREST EMERGENCY EQUIPMENT:

Item:	Location
Eyewash / Safety Shower	
First Aid Kit	
Chemical Spill Kit	
Fire Extinguisher	
Telephone	
Fire Alarm Manual Pull Station	

DESCRIBE INSTITUTION'S EMERGENCY PROCEDURES:

Personnel Exposure procedures

1. Flush contamination from eyes/skin using the nearest emergency eyewash /shower for a minimum of 15 minutes. Remove any contaminated clothing.
2. Take copy of MSDS(s) of chemical(s) when seeking medical treatment.
3. Report potential exposures to your Principal Investigator/Laboratory Supervisor.
4. File an incident report with your institution.

Spill Response procedures

1. **Notify.** Alert workers near spill to avoid entering the area. Post signs in area or on door of lab. Eliminate sources of ignition. Report spill to your Principal Investigator/Lab Supervisor.
2. **Assess.** Are you able to cleanup spill yourself?
   - ☐ YES
     *Proceed with **Spill Cleanup** if it is a small spill (i.e., 30 mL), you are knowledgeable about the hazards of the spill, it can be cleaned up within 15 minutes, and an appropriate spill kit is available.*
   - ☐ NO
     Obtain spill assistance. Contact your institution's hazardous materials unit.
3. **Cleanup Spill.** Wear existing PPE (NOTE: Respiratory protection may be required if spill / release is outside the engineering control device).
   For powders:
   - *Use a dedicated, approved HEPA vacuum whose filtration effectiveness has been verified.*
   - *Do not sweep dry nanoparticles or use compressed air.*
   - *Consider possible pyrophoric hazards associated with vacuuming up nanoparticles.*
   - *Wet wipe using damp cloths with soaps or cleaning oils, or commercially available wet or electrostatic microfiber cleaning cloths. Consider possible reactivity of nanoparticles with the wipe solvent..*

   For liquid dispersions:
   - *Apply absorbent material (appropriate for the solvent in the dispersion) to liquid spill.*
4. **Dispose.** Dispose of used cleaning materials and wastes as hazardous waste.
5. **Report**. File incident report with your institution.

TRAINING

GENERAL SAFETY TRAINING. DESCRIBE YOUR INSTITUTION'S GENERAL LABORATORY SAFETY TRAINING.

LABORATORY-SPECIFIC TRAINING. (CHECK ALL THE APPLY)

☐ **REVIEW** THIS NANOTOOL

☐ **REVIEW** THE MSDS FOR THE NANOMATERIAL(S), *if available*

☐ **REVIEW** THE MSDS FOR OTHER CHEMICALS INVOLVED IN THE EXPERIMENT / PROCESS

☐ **REVIEW** THIS SOP

☐ **OTHER:**

DISPOSAL

INDICATE THE NANOMATERIAL WASTE MANAGEMENT PROCEDURES TO BE UTILIZED.

	Waste Stream	Management Method
☐	**Solid** • Dry ENM product • Filter media containing ENMs • Debris / dust from ENMs bound in matrix	1. Manage according to hazardous waste program requirements at your institution. 2. Label nanomaterial waste containers at all times. Specify the nanomaterial and its hazard characteristic (or the hazard characteristic of the parent material) on container labels; label information to contain the word "nano" as a descriptor. 3. Keep containers closed at all times when not in use. 4. Maintain containers in good condition and free of exterior contamination. 5. Collect waste in rigid container with tight fitting lid.
☐	**Liquid** • Suspensions containing ENMs	1. Manage according to hazardous waste program requirements at your institution. 2. Label nanomaterial waste containers at all times. Specify the nanomaterial and its hazard characteristic (or the hazard characteristic of the parent material) on container labels; label information to contain the word "nano" as a descriptor. 3. Keep containers closed at all times when not in use. 4. Maintain containers in good condition and free of exterior contamination. 5. Indicate both the chemical constituents of the solution and their hazard characteristics, and the identity and approximate percentage of ENMs on container labels. 6. Use leak proof containers that are compatible with all contents. 7. Place liquid waste containers in secondary containment and segregate from incompatible chemicals during storage.
☐	**Laboratory trash with trace nanomaterials** • PPE • Sticky mats • Spill clean-up materials	1. Manage according to hazardous waste program requirements at your institution. 2. Label nanomaterial waste containers at all times. Specify the nanomaterial and its hazard characteristic (or the hazard characteristic of the parent material) on container labels; label information to contain the word "nano" as a descriptor. 3. Keep containers closed at all times when not in use. 4. Maintain containers in good condition and free of exterior contamination. 5. Dispose of in double clear plastic bags, folded over and taped at the neck. 6. Avoid rupturing the bags during storage and transport.
☐	**Solid Matrix** embedded with nanomaterials (intact and in good condition)	1. Consult with your EH&S department, as these materials may be non-hazardous.

DESCRIBE INSTITUTION'S WASTE MANAGEMENT PROCEDURES HERE (IF APPLICABLE):

Acknowledgement. *By signing this form the individual certifies that the information provided is true and correct to the best of their knowledge.*	PRINT NAME / SIGNATURE	DATE:

Appendix B

Standard Operating Procedures (SOP) sample

For the Laboratory Use of Engineered Nanomaterials

Instructions: Review the ***Quick Guide: Risk Levels and Control Measures for Nanomaterials***. Use this template to develop a Standard Operating Procedure for your experiment / process.

OVERVIEW

PROCEDURE TITLE:
Use of fluorescent nanocrystals as biological markers

DATE OF CREATION / REVISION:
09/24/2011

LOCATION:
(Building, Room #) ***Sproul Hall 4127***

PRINCIPAL INVESTIGATOR (PI) OR LABORATORY SUPERVISOR NAME:	PHONE:	EMAIL:
Jane Doe	***(951) 827-6303***	***jane.doe@university.edu***

DESCRIPTION. PROVIDE A 1-2 SENTENCE BRIEF DESCRIPTION OF THE PROCESS. INDICATE IF AEROSOLS ARE LIKELY TO BE CREATED.

To achieve high optical density, maintain thinness, and prevent photodegredation, fluorescent nanocrystals will be used (over organic dyes) as biological markers. This study will also investigate fabrication of nanocomposites (polymer spheres) to avoid slow recognition kinetics and high non-specific bonding.

MATERIAL STATE AND CONDITIONS OF USE	FREQUENCY (check one):	DURATION PER EXPERIMENT:
Nanomaterials are handled in/as: ☐ **DRY PARTICLES** (POWDERS / PELLETS) ☑ **SUSPENSION / GELS** ☐ **GASEOUS PHASE**	☐ **ONE TIME** ☐ **DAILY** ☑ **WEEKLY** ☐ **MONTHLY** ☐ **OTHER:**	***30*** MINUTES; OR ________ HOURS

HAZARDS

RISK LEVEL:

☐ **CATEGORY 1**: LOW POTENTIAL FOR EXPOSURE
☑ **CATEGORY 2**: MODERATE POTENTIAL FOR EXPOSURE
☐ **CATEGORY 3**: HIGH POTENTIAL FOR EXPOSURE

POTENTIAL HAZARDS. IDENTIFY POTENTIAL CHEMICAL AND SAFETY HAZARDS USING THE MATERIAL SAFETY DATA SHEET (MSDS) FOR THE NANOMATERIAL OR PARENT COMPOUND. THE TOXICITY OF THE NANOMATERIALS MAY BE GREATER THAN THE PARENT COMPOUND. SPECIAL CONSIDERATION SHOULD BE GIVEN TO THE HIGH REACTIVITY OF SOME NANOPOWDERS WITH REGARD TO POTENTIAL FIRE AND EXPLOSION, PARTICULARLY IF SCALING UP THE PROCESS. CONSIDER THE HAZARDS OF ANY PRECURSOR MATERIALS IN EVALUATING THE PROCESS. FOR MORE INFORMATION, REFER TO THE SECTION ON "PLANNING YOUR RESEARCH".

Chalcogen oxide is harmful if inhaled or ingested. Chemical is incompatible with strong bases.
Cadmium Selenide (CdSe) is harmful if inhaled or ingested or when in contact with skin. Chemical is incompatible with acids.

INSTRUCTIONS: INDICATE THE ENGINEERING, WORK PRACTICE, AND PERSONAL PROTECTIVE EQUIPMENT (PPE) CONTROLS YOU WILL BE IMPLEMENTING TO REDUCE THE HAZARDOUS EFFECTS OF WORKING WITH YOUR NANOMATERIALS. BASE YOUR SELECTION ACCORDING TO THE "QUICK GUIDE" SECTION.

CONTROLS

ENGINEERING CONTROLS. INDICATE ENGINEERING DEVICE(S) TO BE UTILIZED. NOTE: IF WORK CANNOT BE CONDUCTED WITH APPROPRIATE ENGINEERING CONTROLS, CONSULT WITH AN EH&S PROFESSIONAL.

- ☐ **FUME HOOD** *(laboratory-type)*
- ☑ **BIOSAFETY CABINET** *(must be ducted if used in conjunction with volatile compounds)*
- ☐ **ENCLOSED SYSTEM** *(i.e., glove box, glove bag, or sealed chamber)*
- ☐ **POWDER HANDLING ENCLOSURE**
- ☐ **OTHER:**

WORK PRACTICE CONTROLS. THE FOLLOWING CONTROLS WILL BE IMPLEMENTED *(check all that apply):*

☑ Category 1 work practices

- **STORE** in sealed container with secondary containment with other compatible chemicals
- **LABEL** chemical container with the identity of contents and include term "nano" as descriptor
- **TRANSFER** in sealed container with secondary containment
- **PREPARE** work space by lining with absorbent materials
- **CLEAN** all surfaces potentially contaminated with nanoparticles (e.g., benches, glassware, apparatus) at the end of each operation using a HEPA vacuum and/or wet wiping methods.
- **WASH** hands frequently. Upon leaving the nanomaterial work area, remove any PPE worn and wash hands, forearms, face, and neck.
- **NOTIFY** in advance of animal facility and cage labeling / management requirements if dosing animals with nanomaterial

☑ Category 2 work practices

- **FOLLOW** all work practices listed for Category 1.
- **RESTRICT ACCESS.**
- **POST** signs in area
- **USE** antistatic paper and/or sticky mats with powders.

☐ Category 3 work practices

- **FOLLOW** all work practices listed for Category 2.

☐ **Approvals Required.** IDENTIFY TASKS THAT REQUIRE PRIOR APPROVAL BY THE PRINCIPAL INVESTIGATOR / LABORATORY SUPERVISOR BEFORE PERFORMING:

Obtain PI approval prior to procuring (purchasing) nanomaterials.

☐ **Other**. DESCRIBE ANY ADDITIONAL WORK PRACTICES SPECIFIC TO THE EXPERIMENT / PROCESS:

PERSONAL PROTECTIVE EQUIPMENT (PPE). INDICATE THE PPE TO BE UTILIZED *(check all that apply):*

Body Protection:	☑ Long pants (no cuffs) ☐ Laboratory coat *made of standard materials* ☑ Laboratory coat *made of non-woven fabrics with elastics at wrists (i.e., Tyvek®)* ☐ Coveralls (disposable) with head coverage *(i.e., Tyvek®)*
Eye / Face Protection:	☐ Safety glasses with side shields ☑ Chemical splash goggles ☐ Face shield
Hand Protection:	☐ Latex ☑ Nitrile ***(2 layers)*** ☐ Neoprene ☐ Vinyl ☐ Other:
Foot Protection:	☑ Closed toe shoes ☐ Over-the-shoe booties
Other:	☐ Respiratory Protection* ☐ Other:

* Consult with your institution on respiratory program requirements

ACCIDENT AND SPILL PROCEDURES

LOCATION OF NEAREST EMERGENCY EQUIPMENT:

Item:	Location
Eyewash / Safety Shower	*Outside main door of in Sproul Hall 4127*
First Aid Kit	*Under sink in Sproul Hall 4127*
Chemical Spill Kit	*Under sink in Sproul Hall 4127*
Fire Extinguisher	*On the fourth floor of Sproul Hall, near restrooms*
Telephone	*On desk in corner of Sproul Hall 4127*
Fire Alarm Manual Pull Station	*On the fourth floor of Sproul Hall, near restrooms*

DESCRIBE INSTITUTION'S EMERGENCY PROCEDURES:

Follow "In Case of an Accident" poster affixed to laboratory door

Personnel Exposure procedures

1. Flush contamination from eyes/skin using the nearest emergency eyewash /shower for a minimum of 15 minutes. Remove any contaminated clothing.
2. Take copy of MSDS(s) of chemical(s) when seeking medical treatment.
3. Report potential exposures to your Principal Investigator/Laboratory Supervisor.
4. File an incident report with your institution.

Spill Response procedures

1. **Notify.** Alert workers near spill to avoid entering the area. Post signs in area or on door of lab. Eliminate sources of ignition. Report spill to your Principal Investigator/Lab Supervisor.
2. **Assess.** Are you able to cleanup spill yourself?

   IF YES

   *Proceed with **Spill Cleanup** if it is a small spill (i.e., 30 mL), you are knowledgeable about the hazards of the spill, it can be cleaned up within 15 minutes, and an appropriate spill kit is available.*

   IF NO

   Obtain spill assistance. Contact your institution's hazardous materials unit.
3. **Cleanup Spill.** Wear existing PPE (NOTE: Respiratory protection may be required if spill / release is outside the engineering control device).

   For powders:
   - *Use a dedicated, approved HEPA vacuum whose filtration effectiveness has been verified.*
   - *Do not sweep dry nanoparticles or use compressed air.*
   - *Consider possible pyrophoric hazards associated with vacuuming up nanoparticles.*
   - *Wet wipe using damp cloths with soaps or cleaning oils, or commercially available wet or electrostatic microfiber cleaning cloths. Consider possible reactivity of nanoparticles with the wipe solvent..*

   For liquid dispersions:
   - *Apply absorbent material (appropriate for the solvent in the dispersion) to liquid spill.*
4. **Dispose.** Dispose of used cleaning materials and wastes as hazardous waste.
5. **Report**. File incident report with your institution.

TRAINING

GENERAL SAFETY TRAINING. DESCRIBE YOUR INSTITUTION'S GENERAL LABORATORY SAFETY TRAINING.

Laboratory Safety Orientation, Hazardous Waste Management, and Chemical Hygiene are required of all users prior to working in the laboratory. All courses are available online at http://www.university.edu

LABORATORY-SPECIFIC TRAINING. (CHECK ALL THE APPLY)

☑ **REVIEW** THIS NANOTOOL

☑ **REVIEW** THE MSDS FOR THE NANOMATERIAL(S), *if available*

☑ **REVIEW** THE MSDS FOR OTHER CHEMICALS INVOLVED IN THE EXPERIMENT / PROCESS

☑ **REVIEW** THIS SOP

☐ **OTHER:**

DISPOSAL

INDICATE THE NANOMATERIAL WASTE MANAGEMENT PROCEDURES TO BE UTILIZED.

	Waste Stream	Management Method
☐	**Solid** • Dry ENM product • Filter media containing ENMs • Debris / dust from ENMs bound in matrix	1. Manage according to hazardous waste program requirements at your institution. 2. Label nanomaterial waste containers at all times. Specify the nanomaterial and its hazard characteristic (or the hazard characteristic of the parent material) on container labels; label information to contain the word "nano" as a descriptor. 3. Keep containers closed at all times when not in use. 4. Maintain containers in good condition and free of exterior contamination. 5. Collect waste in rigid container with tight fitting lid.
☑	**Liquid** • Suspensions containing ENMs	1. Manage according to hazardous waste program requirements at your institution. 2. Label nanomaterial waste containers at all times. Specify the nanomaterial and its hazard characteristic (or the hazard characteristic of the parent material) on container labels; label information to contain the word "nano" as a descriptor. 3. Keep containers closed at all times when not in use. 4. Maintain containers in good condition and free of exterior contamination. 5. Indicate both the chemical constituents of the solution and their hazard characteristics, and the identity and approximate percentage of ENMs on container labels. 6. Use leak proof containers that are compatible with all contents. 7. Place liquid waste containers in secondary containment and segregate from incompatible chemicals during storage.
☑	**Laboratory trash with trace nanomaterials** • PPE • Sticky mats • Spill clean-up materials	1. Manage according to hazardous waste program requirements at your institution. 2. Label nanomaterial waste containers at all times. Specify the nanomaterial and its hazard characteristic (or the hazard characteristic of the parent material) on container labels; label information to contain the word "nano" as a descriptor. 3. Keep containers closed at all times when not in use. 4. Maintain containers in good condition and free of exterior contamination. 5. Dispose of in double clear plastic bags, folded over and taped at the neck. 6. Avoid rupturing the bags during storage and transport.
☐	**Solid Matrix** embedded with nanomaterials (intact and in good condition)	1. Consult with your EH&S department, as these materials may be non-hazardous.

DESCRIBE INSTITUTION'S WASTE MANAGEMENT PROCEDURES HERE (IF APPLICABLE):

Use the University Online Tag Program (OTP) to schedule pickup of hazardous waste with EH&S.

Acknowledgement. *By signing this form the individual certifies that the information provided is true and correct to the best of their knowledge.*	PRINT NAME / SIGNATURE Jane Doe	DATE: ***09/24/2011***

Appendix C

Additional Information

Health Effects

Table 3. Select publications on the health effects of nanomaterials.[22]

Effect	Particle	Reference
Deposit in the alveoli	Ultrafine TiO_2 SWCNT	Sager et al. 2008 Shvedova et al. 2005 Mercer et al. 2008
Evade phagocytosis	SWCNT	Mercer et al. 2008
Enter alveolar walls	SWCNT TiO_2	Mercer et al. 2008 Oberdörster et al. 1994
Produce interstitial inflammation	Ultrafine carbon black	Nikula et al. 1995
Produce fibrosis	SWCNT	Shvedova et al. 2005 Mercer et al. 2008
Produce tumors	Ultrafine TiO_2	Heinrich et al. 1995
Form granulomas	SWCNT	Shvedova et al. 2005

Naturally Occurring Nanomaterials

Table 4. Sources, Notes, and Exposure limits for select naturally occurring nanomaterials

Types	Amorphous Silica	Carbon Black
Sources	Crystalline silica is abundant in sand and soils, rocks (sandstone, granite), minerals (quartz). Amorphous silica is far less abundant in nature (diatomaceous earth, silica glass and opal) but is commonly manufactured[14, 15]	Carbon black is a powdered form of elemental carbon. Worldwide production of carbon black in 1993 was approximately 6 million tonnes. Typical classes of chemicals adsorbed onto the carbon black surface are polycyclic aromatic hydrocarbons (PAHs) [16]
Notes	Used for industrial applications such as flow agents, anti-caking agents and flavor carriers in food, polishing agents in toothpastes, flattening agents and thickeners in paints, etc. Man-made silica nanoparticles include: Mesoporous, colloidal, precipitated, and pyrogenic. A few examples of the applications are: cosemetics, drugs, food additives, and drug delivery systems. Contrary to the well-studied crystalline micron-sized silica, relatively little information exists on the toxicity of its amorphous and nano-size forms[15]	Carbon Black is an IARC Group 2B Possible Carcinogen. Carbon black is used mainly in products containing rubber products, such as automobile tires, hoses, gaskets and coated fabrics. Carbon black is also used in much smaller amounts in plastics, inks, paints, dry-cell batteries. [16]
Exposure Limits	Cal/OSHA (respirable): **PEL:** 3 mg/ m^3 OSHA: **PEL:** 80 mg/ m^3 NIOSH: **REL** :6 mg/ m^3 ACGIH (respirable): **TLV:** 3 mg/ m^3	Cal/OSHA: **PEL:** TWA 3.5 mg/m^3 OSHA: **PEL:** TWA 3.5 mg/m^3 NIOSH: **REL:** TWA 3.5 mg/m^3 TWA 0.1 mg/m^3 for carbon blacks with > 0.1% PAH ACGIH: **TLV:** TWA 3.5 mg/m^3

Regulations

Governmental Agencies and Relevant Legislation to Nanomaterials (as of 2011)

- **European Union**
  Registration, Evaluation, Authorization, and Restriction of Chemical Substances, 2007 (REACH)
- **US Environmental Protection Agency (EPA)**
  Toxic Substances Control Act (1976)
- **Cal EPA Department of Toxic Substance Control (DTSC)**
  Assembly Bill 1879 and Senate Bill 509
- **Occupational Safety and Health Administration (OSHA)**
  Nanomaterials fall under OSHA General Industry Standards[17]

European Union | REACH[18]

REACH does not specifically refer to nanomaterials, but nanomaterials are included under the definition of a "substance" in this legislation. In general, REACH requires registration of substance manufactured or imported at 1 metric ton or more, but the initial (November 2010) registration deadline only applies to substances that are manufactured or imported in quantities at 1000 metric tons or more per year. This registration will provide information that is essential to understanding and evaluating the risks associated with specific substances, particularly nanomaterials, since value-chain information for most nanomaterials is currently lacking.

In addition, Classification, Labelling and Packaging of Nanomaterials in REACH and CLP, an amendment to REACH, specifies how hazardous substances must be handled within the EU; nanomaterials that fulfill the criteria for hazardous provided under this regulation must be classified, labeled, and packaged as such. Manufacturers and importers in the EU of nanomaterials that meet these criteria were required to notify the ECHA by January 2011.

An expert group that advises the European Commission on how to manage nanomaterials in accordance with REACH and CLP has released several documents, including:

- Nanomaterials in REACH
  Provides an overview of how REACH applies to nanomaterials
- Classification, Labelling and Packaging of Nanomaterials in REACH and CLP
  Describes how to classify nanomaterials in accordance with REACH and the CLP Regulation.

US EPA | Toxic Substances Control Act (1976)[19]

In the United States, Toxic Substances Control Act of 1976 (TSCA) is the primary federal legislation that regulates toxic substances. TSCA requires manufactures of new chemical substances to provide information to the EPA prior to manufacturing or introducing new substances into commerce. Under TSCA, the EPA has the authority to control substances that pose an "unreasonable risk to human health or the environment". On April 4, 2012, the US EPA issued a Significant New Use Rule (SNUR) that states that "infused carbon nanostructures (generic) are subject to premanufacture notice (PMN)." This SNUR require persons who intend to manufacture, import, or process new carbon nanostructures to submit a Significant New Use Notice (SNUN) to EPA at least 90 days before commencing that activity. Additional rules related to other types of nanomaterials are expected to be issued from the EPA in the future and individuals wishing to use nanomaterials commercially are encouraged to check the EPA's website for more current information: http://epa.gov/oppt/nano

For an overview of how the TSCA impacts worker health related to nanomaterials see: Sayre, P., S. Prothero, and J. Alwood, *Nanomaterial Risk Assessment and Management Experiences Related to Worker Health Under the Toxic Substances Control Act.* Journal of Occupational and Environmental Medicine, 2011. **53**(6 Supplement): p. S98-S102.

Cal EPA (DTSC) | Assembly Bill 1879 & Senate Bill 509

Two California Green Chemistry Initiative Statutes, Assembly Bill 1879 and Senate Bill 509 provide the Cal EPA/ DTSC with greater authority to regulate toxic substance in consumer products than the federal statues and to create an online Toxics Information Clearinghouse to provide Californians with information on hazardous chemicals. Although these statutes apply to chemical substance more broadly, DTSC has used this authority to create a chemical call-in program for some specific nanomaterials. Thus far, carbon nanotubes, nano cerium oxide, nano silver, nano titanium dioxide, nano zero valent iron, nano zinc oxide, and quantum dots have been included in the call in. The call in requires manufacturers and importers of these materials in the state of California to provide information on their products, including, but not limited to, known toxicological data and supply chain information.[20, 21]

Other Regulatory Drivers

OECD
Defines terms, and standardize protocols for safety testing.
OECD Nanomaterials Website

Reference

1 Lövestam, G., Rauscher, H., et al. (2010). Considerations on a Definition of Nanomaterial for Regulatory Purpose. *Joint Research Centre (JRC) Reference Reports*. Luxembourg, European Union [ISO TS 80004-1]

2 Council for Science and Technology Nanosciences and Nanotechnologies. (2007). A Review of Government's Progress on Its Policy Commitments. *Nano Review* (11). London.

3 Good Nano Guide. (2007, March 13). *What are nanomaterials?* Retrieved June 16, 2011 from http://goodnanoguide.org/tiki-index.php?page=What+are+nanomaterials; and American Chemistry Council, Nanotechnology Panel. (2007, March 13). *Consideration for a Definition for Engineered Nanomaterials*. Retrieved June 16, 2011 from http://www.americanchemistry.com

4 Peters, A., Ruckerl, R., et al. (2011). Lessons From Air Pollution Epidemiology for Studies of Engineered Nanomaterials. *Journal of Occupational and Environmental Medicine* 53 (6 Supplement): S8-S13.

5 Castranova, V. (2011). Overview of Current Toxicological Knowledge of Engineered Nanoparticles. *Journal of Occupational and Environmental Medicine* 53 (6 Supplement): S14-S17.

6 Nohynek, G. J., EDufour, E.K., et al. (2008). Nanotechnology, Cosmetics and the Skin: Is There a Health Risk? *Skin Pharmacology and Physiology* 21(3): 136-149.

7 Sadrieh, N., Wokovich, A.M., et al. (2010). Lack of Significant Dermal Penetration of Titanium Dioxide from Sunscreen Formulations Containing Nano- and Submicron-Size TiO2 Particles. *Toxicological Sciences* 115 (1): 156-166.

8 Wu, J., Liu, W., et al. (2009). Toxicity and penetration of TiO2 nanoparticles in hairless mice and porcine skin after subchronic dermal exposure. *Toxicology Letters* 191 (1): 1-8.

9 OSHA. *Nanotechnology Standards*. Retrieved June 24, 2011 from http://www.osha.gov/dsg/nanotechnology/nanotech_standards.html

10 NIOSH. (2010). Occupational Exposure to Carbon Nanotubes and Nanofiber [DRAFT]. *Current Intelligence Bulletin*. Rationale: "In this risk analysis, NIOSH has determined that workers may be at risk of developing adverse respiratory health effects if exposed for a working lifetime at the upper limit of quantitation (LOQ) of NIOSH Method 5040, currently the recommended analytical method for measuring airborne CNT. The LOQ for NIOSH Method 5040 is 7 µg/m3. Specifically, the animal data-based risk estimates indicate that workers may have >10% excess risk of developing early stage pulmonary fibrosis if exposed over a full working lifetime at the upper LOQ for NIOSH Method 5040. Until improved sampling and analytical methods can be developed, and until data become available to determine if an alternative exposure metric to mass may be more biologically relevant, NIOSH is recommending a REL of 7 µg/m3 elemental carbon (EC) as an 8-hr TWA respirable mass airborne concentration."

11 NISOH. (2011). Occupational Exposure to Titanium Dioxide. *Current Intelligence Bulletin* 63. Rationale: "NIOSH recommends airborne exposure limits of 2.4 mg/m3 for fine TiO2 and 0.3 mg/m3 for ultrafine (including engineered nanoscale) TiO2, as time-weighted average (TWA) concentrations for up to 10 hr/day during a 40-hour work week. These recommendations represent levels that over a working lifetime are estimated to reduce risks of lung cancer to below 1 in 1,000. The recommendations are based on using chronic inhalation studies in rats to predict lung tumor risks in humans."

12 Recommended Spill Kit Contents:

- Latex or Nitrile gloves
- Disposable laboratory coat w/elastic wrists or Tyvek suit
- Absorbent material
- Pre-moistened wipes
- Sealable plastic bags and tape
- Hazardous waste containers with leak proof caps
- Walk off mats (e.g., Tacki-Mat)
- Dedicated HEPA vacuum, labeled 'For Nanomaterials Only'
- Hazardous waste labels
- 'Do not enter – Nanomaterial Spill Clean-up in Progress' sign

13 *Ibid.*

14 Nenogenotox (2010). *Definitions Glossary.* Retrieved June 15, 2011 from http://www.nanogenotox.eu/index.php?option=com_glossary&id=57&Itemid=100

15 Napierska, D., Thomassen, L. CJ, Lison, D., Martens, J.A., & Hoet, P.H. (2010). The nanosilica hazard: another variable entity. *Particle and Fibre Toxicology, 7:39*. Retrieved March 26, 2012 from http://www.particleandfibretoxicology.com/content/7/1/39

16 International Agency for Research on Cancer. (1996). *Carbon Black*, p. 149. Retrieved March 26, 2012 from http://www.inchem.org/documents/iarc/vol65/carbon.html

17 *Ibid.* (See Reference 9)

18 European Commission. (2011). *Chemicals: REACH and nanomaterials.* Retrieved June 24, 2011 from http://ec.europa.eu/enterprise/sectors/chemicals/reach/nanomaterials/index_en.htm

19 Environmental Protection Agency. (2011). *Control of nanoscale materials under the Toxic Substances Control Act.* Retrieved June 24, 2011 from http://www.epa.gov/opptintr/nano

20 Department of Toxic Substances Control. (2011). *DTSC and Nanotechnology.* Retrieved June 24, 2011 from http://www.dtsc.ca.gov/TechnologyDevelopment/Nanotechnology/nanoport.cfm

21 Department of Toxic Substances Control. (2011). *Green Chemistry.* Retrieved June 24, 2011 from http://www.dtsc.ca.gov/PollutionPrevention/GreenChemistryInitiative/index.cfm

22 Courtesy of Dr. Paul Schulte, NIOSH

APPENDIX F:SOP INSTRUCTIONS AND HAZARD CLASS SOPS

INSTRUCTIONS FOR COMPLETING STANDARD OPERATING PROCEDURES (SOPS)

To be in compliance with the Cal/OSHA Laboratory Standard, laboratory-specific Standard Operating Procedures (SOPs) are required to be included in your Chemical Hygiene Plan. You may work with your departmental safety committee and EH&S, as required. EH&S maintains a library of SOP templates (http://www.sop.ehs.ucla.edu/) to further aid in the development of laboratory-specific research procedures. Below are instructions for completing the Hazardous Chemical SOPs with the corresponding template. Please contact your designated Laboratory Safety Officer with any questions or comments you may have while completing your SOPs.

1. Type of SOP

- **Process**: the SOP will be for a process such as distillation, synthesis, etc.
- **Hazardous chemical**: the SOP will be for an individual chemical such as arsenic, formaldehyde, nitric acid, etc.
- **Hazard class:** the SOP will be for a hazard class of chemicals such as oxidizer, flammable, corrosive, etc.

2. Purpose

Brief description of how the chemical is used in the lab along with any information which describes why an SOP is important for the chemical of interest**.**

3. Physical and Chemical Properties/Definition of Chemical Group

Provide basic information on the chemical of interest including the CAS#.

4. Potential Hazards/Toxicity

Describe all the potential hazards for each process, hazardous chemical, or hazard class. Describe the potential for both physical and health hazards. Health hazards include carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents that damage the lungs, skin, eyes, or mucous membranes. State the potential for chronic and/or acute health hazard effects of the chemical(s).

Physical hazards include radioactivity, cryogen, high temperature, electrical, compressed gas or other pressure systems, UV light, laser, flammable or combustible, corrosive, water-reactive, unstable, oxidizer, pyrophoric, explosive, or peroxide formers.

5. Personal Protective Equipment (PPE)

Identify the required PPE for the process, hazardous chemical, or hazard class. PPE includes, but is not limited to: gloves, aprons, laboratory coats, safety glasses, goggles, masks, respirators, or face shields.

6. Engineering Controls

Describe or list engineering controls that will be used to prevent or reduce employee exposure to hazards. Examples of engineering controls include fume hoods, glove boxes, interlocks on equipment, and shielding of various kinds.

7. First Aid Procedures

Describe any emergency first aid procedures that should be followed in case of a chemical exposure. Provide specific detail on responses under specific circumstances of exposure (e.g. inhalation, ingestion, skin contact, etc.).

8. Special Handling and Storage Requirements

Describe the storage requirements for hazardous substances, including special containment devices, special temperature requirements, special storage areas or cabinets, chemical compatibility storage requirements, etc. State any policy regarding access to the substance(s). Describe any special procedures, such as dating peroxide forming chemicals on receipt, opening, and disposal. Describe safe methods of transport, such as in a secondary container using a low, stable cart, or using two hands to carry the chemical container.

Indicate the designated area established for experiments using particularly hazardous substances (PHS). A portion of a laboratory bench, a piece of equipment, the fume hood, or the entire laboratory may be considered as a designated area for experiments using PHS.

9. Spill and Accident Procedures

Describe special procedures for spills, releases or exposures (e.g., neutralizing agents, use of fluorescence to detect materials, etc.). Indicate how spills, accidental releases and exposures will be handled. List location of the following emergency equipment: chemical spill clean-up kit, first-aid kit, emergency shower, eyewash, and fire extinguisher.

10. Decontamination Procedures/ Waste Disposal Procedures

Describe specific decontamination procedures for equipment, glassware, or work areas.

Describe the anticipated waste products as well as how waste will be collected and disposed.

11. Safety Data Sheet (SDS) Location

State where the SDSs are kept for the chemicals, or hazardous substances, used in the laboratory. Indicate the location of other pertinent safety information (e.g., references, equipment manuals, etc.).

12. Protocols

Insert a copy of your specific laboratory procedures for the process, hazardous chemical or hazard class. Make sure to include enough details to clearly define the scope of the work being done. For example, if the SOP is for a hazardous chemical include information on the quantities allowed, conditions, and general steps to be taken while using the chemical.

13. Documentation of Training

Include a list of personnel who have reviewed the SOP. At minimum, the Principal Investigator or designee should sign off on all the SOPs. In general, a signature and date of training are needed.

GENERAL CLASSES OF HAZARDOUS CHEMICALS AND STANDARD OPERATING PROCEDURES (SOP)

The following SOPs represent best practices and provide a broad overview of the information necessary for the safe operation of laboratories that utilize potentially hazardous chemicals and other physical hazards found in the lab. It is not intended to be all-inclusive. It is important to note that many chemicals have numerous hazards associated with them. Always refer to a chemical's SDS at Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip) and consult the PI and/or EH&S if you have questions. Please refer to Chapter 3 for additional general rules for working in a chemical lab.

Departments, divisions or other work units engaged in work with potentially hazardous chemicals that have unusual characteristics, or are otherwise not sufficiently covered below must supplement the CHP with their own SOPs. Examples of some chemicals that are outside the overview of these general class SOPs include benzene, formaldehyde, n-butyl lithium, toluene, piranha acid, and aqua regia.

FLAMMABLE AND COMBUSTIBLE LIQUIDS

HAZARD CLASS DESCRIPTION

Flammable and combustible liquids can ignite and cause severe burns or death. Flammables liquids are defined as having a flash point below 100 °F and combustible liquids have a flash point between 100-200 °F. These liquids have a variety of uses inside a laboratory as solvents, reagents, and cleaning solutions.

CONTROLS

- Do not heat flammable liquids with an open flame.
- Avoid ignition sources such as but not limited to heat guns, static electricity, Bunsen burners, etc. Avoid using equipment with exposed wiring.
- If metal containers are used, ensure that they are properly grounded.
- Fire extinguishers should be readily available.
- Wash hands thoroughly after handling flammable and combustible liquids.

PPE

- At minimum long pants (or the equivalent) and closed-toe shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle flammable or combustible liquids.
- Flame resistant laboratory coats should be worn when working with flammable liquids in amounts that pose a greater than de minimus risk as determined by a risk assessment or when any amount is used near an ignition source.
- Protective gloves that are appropriate for the chemical being handled must be worn
- Additional PPE may be required if the chemical has additional hazards associated with it.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS

- At minimum, adequate general laboratory ventilation must be provided to prevent the accumulation of flammable vapors and maintain exposure below any regulatory limits.
- Some flammable and combustible liquids that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Flammables must be used in well-ventilated areas to help prevent the buildup of flammable vapors.
- Thoroughly wash hands after handling.
- Flammable storage cabinets with self-closing hinges must be used in areas where greater than **10 gallons** of flammables are kept.
- Containers larger than **1 gallon (4L)** must be kept inside a flammable storage cabinet.
- Only the amounts needed for the current procedure should be kept on bench tops.
- Packing material and other combustible materials should be discarded and kept away from flammable and combustible liquids.
- Refrigerators and freezers storing flammable liquids must be designed to store flammable liquids with all electrical equipment that meets the requirements for Class I, Division I Electrical Safety Code (NPFA 45 and 70).
- Flammable and combustible liquids must be kept away from oxidizers and other incompatible materials.
- Consult the SDS for chemical specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and equipment appropriate while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult the SDS.

Please use the WASTe online tag program (https://ehs.ucop.edu/waste/) to label hazardous flammable and combustible waste. Dispose when the waste container is 90% full or within 90 days of generation, whichever comes first. Please see the Hazardous Waste Pick Up Schedule (https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule) and the Hazardous Waste website (https://www.ehs.ucla.edu/hazwaste/hazwaste/#management) for additional information.

SDS LOCATION

SDSs for chemicals can be accessed electronically using Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)

OXIDIZERS

HAZARD CLASS DESCRIPTION

An oxidizer is a chemical that initiates or promotes the combustion in other materials. This can either cause fire itself or through the release of oxygen or other gases. Many chemicals are classified as oxidizers and have many uses in the laboratory. Some oxidizers require chemical specific SOPs. Please contact EH&S if you have questions.

CONTROLS

- Containers should be in good condition and compatible with the material.
- Consult PI or EH&S before mixing oxidizing agents with flammable or combustible materials.
- Fire extinguishers should be readily available.
- Wash hands thoroughly after handling oxidizers

PPE

- At minimum long pants (or the equivalent) and closed-toe shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle oxidizers.
- Protective gloves that are appropriate for the chemical being handled must be worn.
- Flame resistant laboratory coats should be worn if mixing oxidizing agents with flammables or combustibles.
- Depending on risk assessment a face shield and/or blast shield may be appropriate.
- Additional PPE may be required if the chemical has additional hazards associated with it.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS

- At minimum adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- Some oxidizers that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Store away from flammable and combustible materials.
- Consult the SDS for chemical specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and equipment appropriate while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult SDS. Please use the WASTe online tag program (https://ehs.ucop.edu/waste) to label hazardous oxidizer waste. Dispose when the waste container is 90% full or within 90 days of generation, whichever comes first. Please see the Hazardous Waste Pick Up Schedule(https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule) and the Hazardous Waste website (https://www.ehs.ucla.edu/hazwaste/hazwaste/#management) for additional information.

SDS LOCATION

SDSs for chemicals can be accessed electronically using Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)

CORROSIVES

HAZARD CLASS DESCRIPTION

A corrosive chemical can cause destruction of living tissue by chemical action at the site of contact. Common classes of corrosives include acids and bases. Corrosives can also damage other substances such as metals. Corrosives are commonly found in research laboratories and used for multiple purposes. Some corrosives require chemical specific SOPs. Please consult EH&S if you have questions.

CONTROLS

- Containers should be in good condition and compatible with the material.
- When diluting, add acid or base to water.
- Wash hands thoroughly after handling corrosives.

PPE

- At minimum long pants (or the equivalent) and closed-toe shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle corrosives.
- Protective gloves that are appropriate for the chemical being handled must be worn.
- Depending on risk assessment, a face shield and/or chemical splash apron may be appropriate.
- Additional PPE may be required if the chemical has additional hazards associated with it.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS

- At minimum adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- Some corrosives that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Store corrosives below eye level.
- Segregate acids from bases.

- Segregate inorganic acids from organic acids.
- Segregate all acids from reactive metals (e.g. sodium potassium, magnesium).
- Segregate acids from azides and cyanides to prevent adverse reactions.
- Concentrated (>1M) liquid corrosives require secondary containment.
- Consult the SDS for chemical specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and equipment appropriate while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult SDS.

Please use the WASTe online tag program (https://ehs.ucop.edu/waste) to label hazardous flammable and combustible waste. Dispose when the waste container is 90% full or within 90 days of generation, whichever comes first. Please see the Hazardous Waste Pick Up Schedule (https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule) and the Hazardous Waste website (https://www.ehs.ucla.edu/hazwaste/hazwaste/#management) for additional information.

SDS LOCATION

SDSs for chemicals can be accessed electronically using Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)

PYROPHORICS, WATER REACTIVES, PEROXIDE FORMING CHEMICALS AND OTHER HIGHLY REACTIVE AND UNSTABLE MATERIALS

HAZARD CLASS DESCRIPTION

Highly reactive or unstable materials have the potential to vigorously polymerize, decompose, condense, or become self-reactive under conditions such as shock, pressure, temperature, light, or contact with another material. Common highly reactive chemicals are explosives, blasting agents, water reactives, pyrophorics, and peroxide forming chemicals. **These chemicals will require additional SOPs and lab specific training.**

Pyrophoric (air reactive): a chemical that is liable to ignite within 5 minutes after coming into contact with air. As such they must be handled in an inert atmosphere by trained personnel only. All pyrophorics must be stored and handled in buildings that are equipped with emergency sprinkler systems. SDSs should be consulted and followed to ensure appropriate storage for these chemicals. Refrigerators and freezers storing pyrophoric liquids must be designed to store flammable liquids with all electrical equipment that meets Class I, Division I requirements. The UCLA EH&S Pyrophoric Liquid Safety video provides information about the safe handling of pyrophoric chemicals and can be viewed online at: https://www.ehs.ucla.edu/training/videos

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.

Water reactive: a chemical that will react with water to produce a toxic or flammable gas. These chemicals must be kept away from water and aqueous solutions. Also avoid storing near or underneath sinks, safety showers, or emergency eye wash stations.

Disposal of Pyrophoric Reagents: Although pyrophoric reagents can be disposed of through the Hazardous Waste pickup, and this is recommended for significant quantities (>200 mL), it is often necessary to quench unused pyrophoric materials using careful hydrolysis. The steps given below are meant to provide general guidelines to consider when developing a quenching protocol in the lab. Detailed quenching protocols must be covered and documented as a lab-directed training for anyone working with pyrophoric materials. A resource for help developing a lab specific quenching protocol can be found here: http://www.cchem.berkeley.edu/rsgrp/SOPs2015/Quenching-Pyrophorics_Sarpong.pdf

Contact Chemical Safety at chemsafety@ehs.ucla.edu if there are any questions concerning quenching pyrophoric materials.

- Quenching should take place in a fume hood clear of flammable chemicals, other than those needed for the quenching reaction, and of combustible materials (Kimwipes, cardboard, etc.)
- First, set up a dry quenching flask for inert reaction conditions. This flask should not be sealed during the quenching reaction as pressure may build up. It is best to have the flask open to flowing inert gas that is connected to a bubbler to prevent pressure build up.
- Second, add a dried and degassed inert solvent such as toluene or heptane to the quenching flask. It is best to add reactive pyrophoric reagents to the diluent rather than in the opposite order.
- Third, place the quenching flask in an ice bath for cooling in order to control the quench reaction. Do not use a dry ice bath (-78 °C) as that is often too cold to allow the quenching reaction to occur, which could allow an uncontrolled reaction upon warming.
- Fourth, transfer the pyrophoric reagent(s) to be quenched to the reaction flask under inert conditions using syringe or cannula transfer techniques.
- Next, slowly add isopropanol to quench the pyrophoric material. Watch the quench for signs of a reaction taking place, like bubbling or heat formation.
- Upon completion of the isopropanol addition, slowly add methanol, a more reactive quenching reagent, to the mixture. Finally, add water dropwise to the mixture to help ensure the quench reaction is complete.
- Once the quench is complete and there are no signs of further reaction, allow it to slowly warm to room temperature by removing it from the ice bath, again watching for any signs of a reaction taking place.
- Once warmed to room temperature, dispose of the quench mixture as hazardous chemical waste.
- Note that aqueous base reacts with metals, particularly aluminum, so do not use metal cans to contain the quenching waste.

Peroxide forming chemicals (PFCs): a chemical that may form potentially explosive organic peroxides. Many of these chemicals are common solvents and care must be taken for solutions containing PFCs. A common practice is the addition of stabilizers (e.g. hydroquinone and BHT) that inhibit the chain reaction of peroxide formation.

Peroxide forming chemicals should be stored in airtight containers in a dark, cool, and dry place. The containers should be labeled with the date received and the date opened. This information, along with the chemical identity should face forward to minimize container handling during inspection.

There are four classes of PFCs which have different storage requirements. Unopened containers of all four classes may be stored up to 18 months from the received date or the expiration date, whichever is sooner. Specific guidelines for allowable storage limits of opened containers based on these classifications are listed below. Extensions may be granted if the lab can demonstrate that the PFCs in question are safe to use.

Minimize the quantity of peroxide forming chemicals stored in the laboratory and dispose of peroxide forming chemicals before peroxide formation. Peroxide concentrations greater than 20 ppm cannot be disposed through the regular campus vendor and may require additional fees to remove.

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.

Class 1 PFCs

Class 1 chemicals form peroxides after prolonged storage. These must be tested monthly for peroxides starting 3 months from opening and disposed within 12 months of opening.

Class 1 PFCs		
Isopropyl ether	Potassium amide	Vinylidene chloride
Divinyl acetylene	Potassium metal	
Divinyl ether	Sodium amide	

Class 2 PFCs

This group of chemicals will readily form peroxides when they become concentrated (e.g., via evaporation or distillation). The concentration process defeats the action of most auto-oxidation inhibitors. As a result, these chemicals should be disposed of within 12 months of opening, and tested monthly for peroxides starting 3 months from opening if uninhibited.

Class 2 PFCs		
Acetaldehyde	Diethyl ether	4-Methyl-2-pentanone
Cumene	1,4-Dioxane	Tetrahydrofuran
Cyclohexene	Dimethoxyethane (glyme)	Tetrahydronaphthalene
Cyclopentene	Furan	Vinyl ethers
Diacetylene	Propyne	
Dicyclopentadiene	Methylcyclopentane	

Class 3 PFCs

This group of chemicals forms peroxides that can initiation polymerization. When stored in a liquid state, the peroxide forming potential dramatically increases. These chemicals should be disposed of or used within 12 months of opening, and tested monthly for peroxides starting 3 months from opening if uninhibited.

Class 3 PFCs		
Acrylic acid	Chlorotrifluoroethylene	Vinyl acetate
Acrylonitrile	Methyl methacrylate	Vinylacetylene
Butadiene	Styrene	2-Vinylpyridine
Chlorobutadiene	Tetrafluoroethylene	
Vinyl chloride (chloroethene)	1,1-Dichloroethene	

Class 4 PFCs

This group of chemicals may form peroxides, but cannot clearly be defined as Class 1, 2, or 3. These chemicals should be disposed of or used within 12 months of opening, and tested monthly for peroxides starting 3 months from opening if uninhibited.

Class 4 PFCs		
1-(2-Chloroethoxy)-2-phen-oxyethane	Allyl phenyl ether	Isobutyl vinyl ether
1-(2-Ethoxyethoxy)ethyl acetate	å-Phenoxypropionyl chloride	Isophorone
1,1,2,3-Tetrachloro-1,3-butadiene	Benzyl 1-naphthyl ether	Isopropyl 2,4,5-trichlorophenoxyacetate
1,1-Dimethoxyethane	Benzyl ether	Limonene
1,2-Bis(2-chloroethoxy)ethane	Benzyl ethyl ether	m,o,p-Diethoxybenzene
1,2-Dibenzyloxyethane	Benzyl methyl ether	Methoxy-1,3,5,7-cyclooctatetraene
1,2-Dichloroethyl ethyl ether	Benzyl n-butyl ether	Methyl p-(n-amyloxy)benzoate
1,2-Diethoxyethane	Bis(2-(methoxyethoxy)ethyl) ether	m-Nitrophenetole
1,2-Epoxy-3-isopropoxypropane	Bis(2-chloroethyl) ether	n-Amyl ether
1,2-Epoxy-3-phenoxypropane	Bis(2-ethoxyethyl) adipate	n-Butyl phenyl ether
1,3,3-Trimethoxypropene	Bis(2-ethoxyethyl) ether	n-Butyl vinyl ether
1,3-Butadiyne	Bis(2-ethoxyethyl) phthalate	n-Hexyl ether
1,3-Dioxepane	Bis(2-methoxyethyl) carbonate	n-Methylphenetole
1,5-p-Methadiene	Bis(2-methoxyethyl) ether	n-Propyl isopropyl ether
1-Ethoxy-2-propyne	Bis(2-methoxyethyl)phthalate	n-Propylether
1-Ethoxynaphthalene	Bis(2-methoxymethyl) adipate	o,p-Ethoxyphenyl isocyanate

1-Octene	Bis(2-n-butoxyethyl) phthalate	o,p-Iodophenetole
1-Pentene	Bis(2-phenoxyethyl) ether	o-Bromophenetole
2,2-Diethoxypropane	Bis(4-chlorobutyl) ether	o-Chlorophenetole
2,4-Dichlorophenetole	Bis(chloromethyl) ether	Oxybis(2-ethyl acetate)
2,4-Dinitrophenetole	Buten-3-yne	Oxybis(2-ethyl benzoate)
2,5-Hexadiyn-1-ol	Chloroacetaldehyde diethylacetal	p-(n-Amyloxy)benzoyl chloride
2-Bromomethyl ethyl ether	Chloroethylene	p-Bromophenetole
2-Chlorobutadiene	Chloromethyl methyl ether	p-Chlorophenetole
2-Ethoxyethyl acetate	Cyclooctene	p-Dibenzyloxybenzene
2-Ethoxyethyl)-o-benzoyl benzoate	Cyclopropyl methyl ether	p-Di-n-butoxybenzene
2-Ethylacrylaldehyde oxime	Di(1-propynyl) ether	Phenoxyacetyl chloride
2-Ethylbutanol	Di(2-propynyl) ether	Phenyl o-propyl ether
2-Ethylhexanal	Diallyl ether	p-Isopropoxypropionitrile
2-Methoxyethanol	Diethoxymethane	p-Phenylphenetone
2-Methoxyethyl vinyl ether	Diethyl acetal	Sodium 8,11,14-eicosatetraenoate
2-Methyltetrahydrofuran	Diethyl ethoxymethylenemalonate	Sodium ethoxyacetylide
3,3-Dimethoxypropene	Diethyl fumarate	ß,ß-Oxydipropionitrile
3-Bromopropyl phenyl ether	Diethylketene	ß-Bromophenetole
3-Ethoxyopropionitrile	Dimethoxymethane	ß-Chlorophenetole
3-Methoxy-1-butyl acetate	Dimethylketene	ß-Methoxypropionitrile
3-Methoxyethyl acetate	Di-n-propoxymethane	tert-Butyl ethyl ether
4,5-Hexadien-2-yn-1-ol	Ethoxyacetophenone	tert-Butyl methyl ether
4-Methyl-2-pentanone	Ethyl ß-ethoxypropionate	Tetrahydropyran
4-Vinyl cyclohexene	Ethyl vinyl ether	Triethylene glycol diacetate
Acrolein	Furan	Triethylene glycol dipropionate
Allyl ether	Isoamyl benzyl ether	Vinylenecarbonate
Allyl ethyl ether	Isoamyl ether	Vinylidene chioride

If old containers of peroxide forming chemicals are discovered in the laboratory, (greater than two years past the expiration date or if the date of the container is unknown), do not handle the container. If crystallization is present in or on the exterior of a container, do not handle the container. Secure it and contact the EH&S Hotline at **310-825-9797** for pick-up and disposal.

Disposal of expired peroxide-forming chemicals may incur a charge of $100 (minimum) per container. When disposing of these chemicals, the laboratory must complete a recharge order request or P39 form (https://ucla.box.com/ehs-recharge-order-request). Disposal of any peroxide forming chemical with a peroxide concentration greater than 20ppm cannot be done through normal campus disposal and may require additional fees if a high hazard waste team is required.

CONTROLS

- Containers should be maintained in good condition.
- Inspect any air free seal on containers with highly reactive and unstable chemicals. If damaged please contact EH&S at **310- 825-9797**.
- Pyrophoric materials must be used and stored in laboratories that are located in buildings that are fully equipped with emergency sprinkler systems.
- All peroxide forming chemicals should be marked with the receiving and opening date.
- All peroxide forming chemicals must be disposed of within 18 months of receiving or before any stamped expiration date whichever is sooner.
- All Class 1 peroxide forming chemicals must be disposed or used within 12 months of opening.
- All Class 2, 3, and 4 peroxide forming chemicals should be disposed or used within 12 months from opening.

PPE

- At minimum long pants (or the equivalent) and closed toed shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle compressed gases.
- Flame resistant laboratory coats should be worn when working with pyrophorics and may be appropriate when handling other highly reactive and unstable chemicals.
- The area of skin between the shoe and ankle should not be exposed.
- Protective gloves that are appropriate for the chemical being handling must be worn.
- Additional PPE may be required if the chemical has additional hazards associated with it.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS

- Use and store in a well ventilated area.
- At minimum adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.

- Some highly reactive and unstable chemicals that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded then a chemical fume hood or other engineering controls will be required.
- Pyrophorics and water reactive chemicals may require the use of glove boxes and/ or other air and water free techniques for use and handling.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Store these chemicals in secondary containers away from incompatibles.
- Thoroughly wash hands after handling.
- Pyrophorics must be stored under inert atmosphere.
- Pyrophoric gases must be stored in an appropriate gas cabinet.
- Refrigerators and freezers storing pyrophorics must be designed to store flammable liquids with all electrical equipment that meets the requirements for Class I, Division I Electrical Safety Code (NPFA 45 and 70).
- Water reactive chemicals must be stored away from water, aqueous solutions, sinks, and showers.
- All peroxide forming chemicals must be labeled with the receiving and opening date.
- Consult the SDS for chemical specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and equipment appropriate while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult SDS. Please use the WASTe online tag program (https://ehs.ucop.edu/waste) to label hazardous flammable and combustible waste. Dispose when the waste container is 90% full or within 90 days of generation, whichever comes first. Please see the Hazardous Waste Pick Up Schedule (https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule) and the Hazardous Waste website (https://www.ehs.ucla.edu/hazwaste/hazwaste/#management) for additional information.

SDS LOCATION

SDSs for chemicals can be accessed electronically using Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)

COMPRESSED GASES

HAZARD CLASS DESCRIPTION

Compressed gas cylinders can pose both physical and health hazards. Gas cylinders are pressurized vessels that pose a physical hazard if the pressure is released suddenly and violently. Many compressed gases also posed the health hazard of asphyxiation. Compressed gases can also present moderate (ammonia) to severe (fluorine gas) health and chemical reactivity hazards.

Numerous gases are required for different reasons in the chemical research laboratory. Some gases have additional hazards such as flammability, toxicity, and/or pyrophoricity.
Additional information can be found at:
UCLA Compressed Gas Cylinder Storage and HandlingCompressed Cylinder Fact Sheet (https://ucla.box.com/ehs-compressed-gas-cylinders)

CONTROLS

- Properly secure all gas cylinders.
- Ensure that gas cylinders and regulators are in good condition.
- Always use an appropriate regulator that is compatible with the gas being used.
- Frequently check for leaks using a dilute detergent such as Snoop.
- Gas lines should also be compatible with the gas being used.
- Flammable and oxidizing gases must be stored at least 20 feet apart.

PPE

- At a minimum, long pants (or the equivalent) and closed-toe shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle compressed gases.
- Protective gloves that are appropriate for the chemical being handled must be worn.
- Additional PPE may be required if the chemical has additional hazards associated with it.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS

- Use and store in a well-ventilated area.
- At a minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- Some compressed gases that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.

- If Permissible Exposure Limits are anticipated to be exceeded then a chemical fume hood or other engineering controls will be required.
- In some cases, oxygen monitors may be required to prevent the risk of asphyxiation.

HANDLING AND STORAGE

- Compressed gas cylinders must be stored with the safety cap when not in use.
- Gas cylinders must be secured by one of three methods.
    - Double chained to the wall (chains placed 1/3rd from the top and 1/3rd from the bottom of the cylinder)
    - In a metal rack with chains
    - In a clam shell
- No more than three gas cylinders can be secured to a single wall-mounted rack.
- Store gas cylinders in a vertical position.
- Only transport gas cylinders secured and with suitable hand truck.
- Only transport with safety cap on.
- Use a freight elevator when available.
- Consult the SDS for chemical specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

In the event of a gas leak or accidental release attempt to close the gas valve if possible, otherwise evacuate and **call 911** from a campus phone or **310-825-1491** from a cell phone. Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Gas cylinders obtained from UCLA Cylinder Management can be returned using instructions on their website. If the cylinder is obtained from an off campus vendor please contact them to determine if they will accept returns.

SDS LOCATION

SDSs for chemicals can be accessed electronically using Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)

CYROGENIC LIQUIDS

HAZARD CLASS DESCRIPTION

Cryogenic liquids can pose both physical and health hazards. Cryogenic liquids can cause frostbite and these liquids often have large volume expansion factors when they boil. As such cryogenic liquids also pose the health hazard of asphyxiation. Common cryogenic liquids found in laboratories include liquid nitrogen and argon.

CONTROLS

- Confirm that the cryogenic tank's safety relief valves have not been modified.
- Under normal conditions, these containers will periodically vent product. Do not plug, remove, or tamper with any pressure relief device.

PPE

- At minimum long pants (or the equivalent) and closed-toe shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle cryogenic liquids.
- Cryogenic gloves should be worn when handling cryogens.
- Based on risk assessment a face shield may be appropriate when handling cryogenic liquids.
- Additional PPE may be required if the chemical has additional hazards associated with it.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS

- Use and store in a well-ventilated area.
- At minimum adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- Oxygen monitors may be required to the prevent risk of asphyxiation.

HANDLING AND STORAGE

- Never allow any unprotected part of the body to come in contact with un-insulated pipes or equipment that contains cryogenic product.
- Do not store cryogenic liquid containers in a horizontal position.
- Do not store in a confined space.
- Only transport cryogenic liquids secured and with suitable hand truck.
- Do not drop, tip, or roll containers on their sides.

- Use a freight elevator when available.
- Only transfer cryogenic liquids into an appropriate container.
- Special care to ensure that Dewar flasks are in good condition and are shielded or wrapped to contain fragments should implosion occurs.
- Consult the SDS for chemical specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Cryogenic liquid tanks obtained from UCLA Cylinder Management can be returned using instructions on their website. If the cylinder is obtained from an off campus vendor please contact them to determine if they will accept returns.

SDS LOCATION

SDSs for chemicals can be accessed electronically using Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)

HIGH TEMPERATURE

HAZARD CLASS DESCRIPTION

High temperature reactions can cause burns from touching hot equipment or from fire. Laboratories will often use heating plates, sand baths, oil baths, heating mantels, ovens, and occasionally open flame to achieve high temperatures.

CONTROLS

- Do not touch items while they are hot.
- Often times, hot and cold items look the same, so assume that heating equipment is hot.
- Job safety analysis may be appropriate for some high temperature experiments. Please contact EH&S with any questions.

PPE

- At minimum long pants (or the equivalent) and closed-toe shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle compressed gases or cryogenic liquids.
- Flame resistant laboratory coats should be worn if an open flame is in use.
- Protective gloves that are appropriate for the hazard must be worn.
- Additional PPE may be required if the chemical has additional hazards associated with it.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS

- At minimum adequate general laboratory ventilation must be provided to maintain exposure to any heated or volatilized substances below any regulatory limits.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.
- When using carcinogens, acute toxicants, and reproductive toxicants in high temperature experiments the use of a chemical fume hood or other engineering control is required.
- Thermocouples can be used to shut off heat in case of thermal runaway.

HANDLING AND STORAGE

- Use and store in a well-ventilated area.
- When heating chemicals be sure to check the materials flash point and smoke point.
- Allow equipment to cool completely before storing.

SPILL AND ACCIDENT PROCEDURE

In case of a detonation of a fire or accident **call 911** from a campus phone or **310-825-1491** from a cell phone. Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and equipment appropriate while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult SDS.

Please use the WASTe online tag program (https://ehs.ucop.edu/waste) to label hazardous flammable and combustible waste. Dispose when the waste container is 90% full or within 90 days of generation, whichever comes first. Please see the Hazardous Waste Pick Up Schedule (https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule) and the Hazardous Waste website (https://www.ehs.ucla.edu/hazwaste/hazwaste/#management) for additional information.

SDS LOCATION

SDSs for chemicals can be accessed electronically using Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)

HIGH PRESSURE

HAZARD CLASS DESCRIPTION

High pressure reactions require special pressure vessels and may require additional controls to avoid rapid swings in pressure that could spontaneously depressurize resulting in serious injuries and/or property damage. Main hazards include impact from an explosion, exposure to hazardous chemicals from uncontrolled release, or fire.

CONTROLS

- Follow all manufacturer instructions when using a pressure vessel.
- Never exceed the recommended pressure for a given container.
- Temperature control may be required to control reaction rates and pressure
- Be aware of possible decomposition products and their effects on the pressure.
- Check seals and other components for corrosion or wear before and after every experiment, and replace if necessary.
- Warn others in the lab of the hazard when high pressure equipment is in use.
- Job Safety Analysis with emergency shutdown procedures should be developed.

PPE

- At minimum long pants (or the equivalent) and closed-toe shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle equipment at high pressure.
- Protective gloves that are appropriate for the chemical being handled must be worn.
- Based on risk assessment a face shield may be appropriate when handling high pressure vessels.
- Additional PPE may be required if the chemical has additional hazards associated with it.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS

- Use and store in a well-ventilated area.
- At minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.
- Some chemicals used in high pressure systems which are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.

- Based on risk assessment a weighted blast shield may be appropriate when handling high pressure vessels.
- Flash-back arrestors should be used when flammable gases are used.

HANDLING AND STORAGE

- During the experiment, monitor for leakage, pressure relief valve discharges, and any sudden changes in temperature or pressure.
- After the experiment, examine the vessel and replace any worn or corroded parts.
- Follow the manufacturer's recommendation regarding decontamination and storage.

SPILL AND ACCIDENT PROCEDURE

In case of a detonation of a pressure reactor **call 911** from a campus phone or **310-825-1491** from a cell phone. Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and equipment appropriate while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult SDS. Please use the WASTe online tag program (https://ehs.ucop.edu/waste) to label hazardous flammable and combustible waste. Dispose when the waste container is 90% full or within 90 days of generation, whichever comes first. Please see the Hazardous Waste Pick Up Schedule (https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule) and the Hazardous Waste website (https://www.ehs.ucla.edu/hazwaste/hazwaste/#management) for additional information.

SDS LOCATION

SDSs for chemicals can be accessed electronically using Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)

ELECTRICAL SAFETY IN THE LAB

HAZARD CLASS DESCRIPTION

Electrical safety inside a lab is very important as general practice and because some laboratory equipment requires high voltage and power. Such equipment includes lasers and electrophoresis power supplies.

CONTROLS

- Power strips must be kept off the ground and away from sinks, chemicals, or other splash hazards.
- Do not overload circuits.
- Do not use extension cords for permanent wiring.
- Do not use any damaged electrical equipment including worn or frayed wiring.
- Do not block electrical panels.
- Do not pull on the cords.
- Properly ground all required equipment.
- Only UCLA approved electricians should modify any wiring or circuits.

PPE

- At minimum long pants (or the equivalent) and closed-toe shoes are required if entering a wet lab. The area of skin between the shoe and ankle should not be exposed.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

SPILL AND ACCIDENT PROCEDURE

In case of a fire or injury call **911** from a campus phone or **310-825-1491** from a cell phone. If possible disconnect the power supply. Do not touch someone who is connected to electricity. Please see Chapter 10 and F-38 for additional information.

PARTICULARLY HAZARDOUS SUBSTANCES

HAZARD CLASS DESCRIPTION

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. Please see UCLA's Particularly Hazardous Substances Policy (Policy 907, http://www.adminpolicies.ucla.edu/pdf/907.pdf) for more information.

Particularly hazardous substances fall under one of three categories.

1. **Acute toxicant**
2. **Reproductive toxicant**
3. **Carcinogen**

Acute toxicants are defined as: 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." Examples include cyanide salts, hydrofluoric acid, and sodium azide.

Reproductive toxicants are defined as: 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, their physician, and Occupational Health (if an employee) before working with substances that are suspected to be reproductive toxins.

Carcinogens are defined as: 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. Carcinogens 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;
3. Listed Carcinogens

Select Carcinogens are materials which have met certain criteria established by the National Toxicology Program or the International Agency for Research on Cancer regarding the risk of cancer via certain exposure routes. (See definition Select Carcinogen.) 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 (https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=10007&p_table=standards)
- Annual Report on Carcinogens (http://ntp.niehs.nih.gov/pubhealth/roc/roc13/index.html) Published by the National Toxicology Program (NTP), including all of the substances listed as "known to be carcinogens" and substances listed as "reasonably anticipated to be carcinogens"
- International Agency for Research on Cancer (IARC) (http://monographs.iarc.fr/ENG/Monographs/PDFs/index.php), including all of Group 1 "carcinogen to humans", Group 2A "probably carcinogenic to humans" and 2B "possibly carcinogenic to humans"

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. A list of Regulated Carcinogens can be found in UCLA Policy 907 (http://www.adminpolicies.ucla.edu/pdf/907.pdf).

Listed Carcinogens is a term referring to a list of thirteen specific chemicals that are the highest hazard class of carcinogens that have further requirements in addition to those of regulated carcinogens. Given these strict regulations for Listed Carcinogen use, handling, and/or storage, UCLA's EH&S must be contacted *before* any work with these agents begins. A list of Listed Carcinogens can be found in Appendix C.

Regulation citation: https://www.dir.ca.gov/title8/5209.html

Special Note: 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 (http://oehha.ca.gov/prop65/prop65_list/Newlist.html). This list is updated regularly updated 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. Many chemicals on this list are considered particularly hazardous substances and the Proposition 65 classification is often noted in a manufacturer's Safety Data Sheet.

All particularly hazardous substances will require additional SOPs and lab specific training; however some common controls and practices are detailed below.

CONTROLS

- Containers should be in good condition and compatible with the material.
- Work of PHS should be conducted in a designated area.
- Wash hands thoroughly after handling Particularly Hazardous Substances.

PPE

- At minimum long pants (or the equivalent) and closed-toe shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle corrosives.
- Protective gloves that are appropriate for the chemical being handling must be worn.
- Depending on risk assessment, a face shield and/or chemical splash apron may be appropriate.
- Additional PPE may be required if the chemical has additional hazards associated with it.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS

- At minimum, a chemical fume hood is required.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Store Particularly Hazardous Substances in secondary containers.
- Label the container, secondary container, and storage location with the appropriate hazard warning.
- Consult the SDS for chemical specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and equipment appropriate while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult SDS. Please use the WASTe online tag program (https://ehs.ucop.edu/waste) to label hazardous flammable and combustible waste. Dispose when the waste container is 90% full or within 90 days of generation, whichever comes first. Please see the Hazardous Waste Pick Up Schedule (https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule) and the Hazardous Waste website (https://www.ehs.ucla.edu/hazwaste/hazwaste/#management) for additional information.

SDS LOCATION

SDSs for chemicals can be accessed electronically using Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)

TOXIC CHEMICALS

HAZARD CLASS DESCRIPTION

Toxic chemicals can refer to chemicals with acute toxicity or chromic toxicity. In addition, toxicity may target a specific organ. This SOP is only for toxic chemicals with an acute toxicity LD50 greater than those outlined in the in UCLA Policy 907(http://www.adminpolicies.ucla.edu/pdf/907.pdf). Also covered in this SOP are hepatotoxins, nephrotoxins, neurotoxins, and hematotoxins.

CONTROLS

- Wash hands thoroughly after handling toxic chemicals.

PPE

- At minimum long pants (or the equivalent) and closed-toe shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle toxic chemicals.
- Protective gloves that are appropriate for the chemical being handled must be worn
- Additional PPE may be required if the chemical has additional hazards associated with it.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS

- At minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- Some toxic chemicals that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Consult the SDS for chemical specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and equipment appropriate while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult SDS. Please use the WASTe online tag program (https://ehs.ucop.edu/waste) to label hazardous flammable and combustible waste. Dispose when the waste container is 90% full or within 90 days of generation, whichever comes first. Please see the Hazardous Waste Pick Up Schedule (https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule) and the Hazardous Waste website (https://www.ehs.ucla.edu/hazwaste/hazwaste/#management) for additional information.

SDS LOCATION

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SENSITIZERS

HAZARD CLASS DESCRIPTION

A sensitizer (allergen) is a chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical. Common chemicals that may cause sensitization include formaldehyde, diazomethane, latex rubber, and metals.

CONTROLS

- Handling processes should minimize the potential for incidental contact.
- Once chemical hypersensitivity is detected any contact with the chemical should be avoided
- Wash hands thoroughly after handling sensitizers.

PPE

- At minimum long pants (or the equivalent) and closed-toe shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle sensitizers.
- Protective gloves that are appropriate for the chemical being handled must be worn.
- Additional PPE may be required if the chemical has additional hazards associated with it.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS

- At minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- Some sensitizers that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Consult the SDS for chemical specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and equipment appropriate while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult SDS. Please use the WASTe online tag program (https://ehs.ucop.edu/waste) to label hazardous flammable and combustible waste. Dispose when the waste container is 90% full or within 90 days of generation, whichever comes first. Please see the Hazardous Waste Pick Up Schedule (https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule) and the Hazardous Waste website (https://www.ehs.ucla.edu/hazwaste/hazwaste/#management) for additional information.

SDS LOCATION

SDSs for chemicals can be accessed electronically using Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)

IRRITANTS

HAZARD CLASS DESCRIPTION
An irritant is a chemical other than a corrosive that can cause a reversible inflammatory effect on living tissue by chemical action at the site of contact. Common examples include acetone, acetic acid, and formic acid.

CONTROLS
- Handling processes should minimize the potential for incidental contact.
- Wash hands thoroughly after handling irritants.

PPE
- At minimum long pants (or the equivalent) and closed-toe shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle irritants.
- Protective gloves that are appropriate for the chemical being handed must be worn.
- Additional PPE may be required if the chemical has additional hazards associated with it. This includes respirators which require training and fit testing through EH&S.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS
- At minimum, adequate general laboratory ventilation must be provided maintain exposure below any regulatory limits.
- Some irritants which are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.

HANDLING AND STORAGE
- Keep containers closed when not in use.
- Consult the SDS for chemical specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE
Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and equipment appropriate while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult SDS. Please use the WASTe online tag program to label hazardous flammable and combustible waste. Dispose when the waste container is 90% full or within 90 days of generation, whichever comes first. Please see the Hazardous Waste Pick Up Schedule and the Hazardous Waste website for additional information.

SDS LOCATION

SDSs for chemicals can be accessed electronically using Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)

NANOMATERIAL

HAZARD CLASS DESCRIPTION

Nanomaterials are a material or particle with any external dimension in the nanoscale (range 1 nm to 100 nm) or having internal structure or surface structure in the nanoscale. Nanomaterials may be naturally occurring or engineered. Common types include nanotubes, nanoparticles, and quantum dots, which may be formed from a variety of materials. Nanomaterials will require additional SOPs and lab specific training. For additional information please see the Nanotoolkit (https://ucla.app.box.com/ehs-nanomaterials-toolkit) or Appendix E.

CONTROLS

- Handling processes should minimize the potential for incidental contact
- Wash hands thoroughly after handling nanomaterials

PPE

- At minimum long pants (or the equivalent) and closed-toe shoes are required. The area of skin between the shoe and ankle should not be exposed.
- ANSI approved safety glasses or goggles, and a properly fitting lab coat are required to handle nanomaterials.
- Protective gloves that are appropriate for the chemical being handled must be worn
- Additional PPE may be required if the chemical has additional hazards associated with it. This includes respirators that require training and fit testing through EH&S.
- See UCLA Policy 905 (http://www.adminpolicies.ucla.edu/pdf/905.pdf) for additional Information.

ENGINEERING/VENTILATION CONTROLS

- At minimum, adequate general laboratory ventilation must be provided to maintain exposure below any regulatory limits.
- Some nanomaterials that are also carcinogens, acute toxicants, and reproductive toxicants require the use of a chemical fume hood.
- If Permissible Exposure Limits are anticipated to be exceeded, then a chemical fume hood or other engineering controls will be required.

HANDLING AND STORAGE

- Keep containers closed when not in use.
- Consult the SDS for chemical specific storage recommendations.

SPILL AND ACCIDENT PROCEDURE

Please see Chapter 10 and F-38 for additional information.

DECONTAMINATION AND WASTE DISPOSAL

Decontaminate bench, fume hoods, and equipment appropriate while wearing proper PPE. Typically soap and water can be used for effective decontamination, but please consult SDS. Please use the WASTe online tag program (https://ehs.ucop.edu/waste) to label hazardous flammable and combustible waste. Dispose when the waste container is 90% full or within 90 days of generation, whichever comes first. Please see the Hazardous Waste Pick Up Schedule (https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule) and the Hazardous Waste website (https://www.ehs.ucla.edu/hazwaste/hazwaste/#management) for additional information.

SDS LOCATION

SDSs for chemicals can be accessed electronically using Chemwatch (https://jr.chemwatch.net/chemwatch.web/account/autologinbyip)

GENERAL SPILL AND ACCIDENT PROCEDURE

The following are general spill and emergency procedures. Please consult the Safety Data Sheet (SDS) and other emergency resources for additional information.

Spills:

- Alert people in immediate area of the spill.
- Determine the chemical nature of the spill and check the SDS.
    - If the material is toxic, volatile, flammable, and/or hazardous:
        - Immediately warn everyone to evacuate the area,
        - Contain the spill if possible,
        - Turn off all electrical and spark producing equipment if possible, and
        - Call **911** from a campus phone or **310-825-1491** from cell phone.
        - Please be prepared to provide information such as name/ type of chemical spilled, any injuries, building, room, location of spill in room, dynamic/static spill, and your contact information.
    - If properly trained, the spill is small (<1L), no other hazard is present, and you are comfortable doing so you may clean the spill yourself.
        - Put up signs or barrier tape to prevent access to the area.
        - Acid spills can be neutralized with a weak solid base (e.g. sodium bicarbonate).
        - Caustic spills can be neutralized with a weak solid acid (e.g. citric acid),
        - Cover with absorbent (e.g. vermiculite or sand) while wearing proper protective equipment.
        - Double bag spill waste in a clear plastic bag, and label it as hazardous waste.
        - Decontaminate the area with soap and water.
        - Bring the waste bag to the next regularly scheduled Hazardous Waste pickup (https://ucla.app.box.com/ehs-hazwaste-pick-up-schedule), or call EH&S at 310-206-1887 to schedule a pick-up.

Spill on body/ clothes:

- Rinse with water for at least 15 minutes.
- If on clothes, remove clothing and rinse in safety shower for a minimum of 15 minutes.
- If on fire, go to the nearest safety shower or stop, drop, and roll.
- Seek medical attention and notify your supervisor and/or EH&S 310-825-9797.

Spill in eyes:

- Immediately rinse eyeballs and inner eyelids for at least 15 minutes in an emergency eye wash station.
- Seek medical attention and notify your supervisor and/or EH&S 310-825-9797.

Ingestion:
- Seek medical attention and notify your supervisor and/or EH&S 310-825-9797.

Inhalation:
- Seek medical attention and notify your supervisor and/or EH&S 310-825-9797.

Injection:
- Wash the affected area with antiseptic soap and water for 15 minutes.
- Page the needle stick nurse by dialing 231 from a campus phone, enter 93333 when prompted and then enter your extension.
- Seek medical attention and notify your supervisor and/or EH&S 310- 825-9797.

Fire:
- If it is large or you are not prepared to extinguish,
    - Evacuate immediately and alert others.
    - Call **911** from a campus phone or **310-825-1491** from cell phone.
    - Please be prepared to provide information such as any injuries, building, room, location of fire, if it is still active, and your contact information.
- If properly trained, the fire is small (trash can sized), and you are confident in extinguishing you can put out the fire yourself.
    - If a fire extinguisher is required use the PASS method.
    - Please see the EH&S Fire Safety in the Laboratory video (https://www.ehs.ucla.edu/training/videos) for additional fire safety information.

All fires, explosions, and gas leaks should be reported by calling 911 (or 310-825-1491 from cell phone).