Chemical Hygiene Plan

The Environmental Health & Safety Department at California State University of San Bernardino (CSUSB) is responsible for the contents and documentation of this plan. Questions regarding chemical handling regulations and/or information contained herein should be directed to this office (Telephone (909) 537-5179).

I. Introduction

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

A. 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 Program and the Biohazard Management Plan respectively. Research involving more than one type of hazard must comply with all applicable regulatory requirements and follow guidance outlined in the relevant safety programs.

The information presented in the CHP 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 Department of Environmental Health and Safety (EH&S). *See Appendix D: Safe Use of Particularly Hazardous Substances* 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, (ext 75179).

B. Regulatory Requirements for CHP

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

- *Title 8, California Code of Regulations (CCR) section 5191, "Occupational Exposures to Hazardous Chemicals in Laboratories" (http://www.dir.ca.gov/title8/5191.html)*
- *Title 8, CCR, Article 110, Sections 5200-5220 regulated carcinogens including, but not to limited to*
    - *Section 5203, "Carcinogen Report of Use Requirements" (http://www.dir.ca/title8/5203.html)*
    - *Section 5209, "Carcinogens*" (*http://www.dir.ca/title8/5209.html)*
- *Title 8, CCR, Section5154.1, "Ventilation Requirements for Laboratory-Type Hood Operations" (http://dir.ca.gov/title8/55154_1.html)*

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

C. 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 handled adequately. 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 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 their laboratory or other facility with hazardous chemicals;
5. Consulting with EH&S and/or Departmental Approving Authority on use of higher risk materials, such as use of particularly hazardous substances, as defined by CSUSB Guidelines, or conduction of higher risk experimental procedures so that special safety precautions may be taken;
6. Maintaining an updated chemical inventory for the laboratory or facility;
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 such training in the Safety Manual;
9. Promptly notifying EH&S and/or Facilities Management 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;
11. Conducting periodic self-inspections of laboratory or facility and maintaining records of inspections, as required;
12. Promptly reporting of accidents and injuries to EH&S. Serious injuries MUST be reported to EH&S immediately to allow for compliance within 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;
15. Identifying and minimizing potential hazards to provide a safe environment for repairs and renovations.

D. 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:

A. Reviewing and following requirements of the CHP and all appropriate Safety Manuals and Policies;
B. Following all verbal and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned;
C. Developing good personal chemical hygiene habits, including but not limited to, keeping the work areas safe and uncluttered;
D. Planning, reviewing and understanding the hazards of materials and processes in their laboratory research or other work procedures prior to conducting work;
E. Utilizing appropriate measures to control identified hazards, including consistent and proper use of engineering controls, personal protective equipment, and administrative controls;
F. Understanding the capabilities and limitation of PPE issued to them;
G. Gaining prior approval from the PI/Laboratory Supervisor for the use of redistricted chemicals and other materials;
H. Consulting with PI/Laboratory Supervisor before using any particularly hazardous substances (PHS), pyrophoric chemicals, explosives and other highly hazardous materials or conducting certain higher risk experimental procedures;
I. Immediately reporting all accidents and unsafe conditions to the PI/Laboratory Supervisor;
J. Completing all required health, safety and environmental training, and provide written documentation to their supervisor;
K. Participating in the Science Safety Committee, when required;
L. Informing the PI/Laboratory Supervisor of any work modifications ordered by a physician as a result of medical surveillance, occupational injury or exposure;
M. 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 the previously reviewed procedures (Note: Significant change may include, but is not limited to change in objectives, change in PI, change in duration, quantity, frequency, conditions 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;
    d. Providing appropriate oversight, training and safety information to laboratory or other personnel they supervise or direct.

E. 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 campus Chemical Hygiene Officer (CHO), Rominna Valentine Ico, is designated by EH&S, and is qualified by training and experience, to provide technical guidance in the development and implementation of provisions of the Chemical

Hygiene Plan. 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 PI/Laboratory Supervisors of all health and safety requiremetns and assisting with the selection of appropriate safety controls, including laboratory and other workplace practices, PPE, 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. Helping to develop and implement appropriate chemical hygiene policies and practices;
5. 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;
6. Working with research staff to review existing SOPs and assist with developing new SOPs for handling hazardous chemicals;
7. Providing technical guidance and investigation, as appropriate, for laboratory and other types of accidents and injuries;
8. Helping to determine medical surveillance requirements for potentially exposed personnel;
9. Reviewing plans for installation of engineering controls and new facility construction/renovation, as requested;
10. Reviewing and evaluating the effectiveness of the CHP at least annually and updating it as appropriate.

F. Responsibilities of the Science Safety Committee (SSC)

The SSC shall function as a cooperative effort for information dissemination and to ensure that the CHP procedures are followed. Committee members 'shall include the EH&S Specialist as Chairperson and Designated Safety Coordinator's (DSC) as members of the committee representing their departments. The committee will support the CHP with the following responsibilities:

1. Submit and prepare agenda items to be discussed at committee meetings.
2. Assist in dissemination of information and regulatory updates.
3. Provide recommendations to assist in the evaluation of safety suggestions.
4. See that appropriate surveys, inventories, and training forms are maintained.
5. Assist departments in developing procedures and policies for operational use when necessary.
6. Review and evaluate various departmental safety concerns and regulatory deficiencies.
7. As a committee collectively prioritize resource allocation to fulfill the safety needs of the various departments.
8. Submit these resource prioritizations through the appropriate channels to ensure resource allocation.
9. Seek ways to improve the CHP.
10. Meet at a minimum quarterly or as requested by the Chairperson.

G. Designated Safety Coordinators (DSC)

It is the responsibility of the DSC's appointed by Department Chairs or Department Heads to ensure compliance with regulatory guidelines and CHP procedures. Further duties shall include but are not limited to the following:

1. Department representative on the CHC.
2. Liaison with the EH&S Department.
3. Assist the departments in development and implementation of EH&S programs.
4. Primary resource person for aiding EH&S activities.
5. Attend established EH&S Train-the-Trainer Programs.
6. Ensure that all department surveys and chemical inventories are completed and returned to the EH&S Department in the requested timeframe.
7. Ensure that all markings, labeling, and identifications per regulatory requirements are in place.
8. Assist and expedite correction of identified deficiencies.
9. Ensure that all regulatory information is disseminated.
10. Provide access to all department employees for safety concerns without fear of reprisal.
11. Prepare written reports and recommendations towards improving compliance with EH&S regulations.

II. Chemical Hazard Communication

A. Regulatory Requirements for Chemical Hazard Communication

CSUSB 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, which is summarized briefly below. CSUSB has an established Hazard Communication Program that complies with Title 8 CCR 5194, the Cal/OSHA Hazard Communication Standard. In line with Cal/OSHA HAZCOM, the purpose of CSUSB's Hazard Communication Program is to ensure that all employees and, upon request, their personal physicians, have the right to receive information regarding the hazardous substances to which they may have been exposed at work. The requirements of the Hazard Communication Program apply to laboratory environments at CSUSB due to the potential for large scale experiments and for activities that may occur outside areas where engineering controls are available. Proper hazard communication involves the active participation of the PI/Laboratory Supervisor, the EH&S Chemical Hygiene Officer, and the Laboratory Stockroom Manager/Technician, who are each responsible for providing consultation and safety information to employees working with hazardous chemicals.

B. List of Hazardous Substances

Every laboratory group is required to keep an updated copy of their chemical inventory on file, which must be made available to EH&S upon request. For each hazardous substance on their inventory, specific information on any associated health or safety hazards must be readily available to all laboratory personnel. Compressed gases need to be included in the chemical inventory.

C. Hazard Determination

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

The term "hazardous substance" refer to any chemical for which there is a 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 substance include, but are not limited to, those chemicals listed in the following:

1. "The Hazardous Substance List," commonly known as the Directors List of Hazardous Substances, 8 CCR 339;
2. "Toxic and Hazardous Substances, Air Contaminants," 8 CCR, Section 5155;
3. "Threshold Limit Values for Chemical Substances in the Work Environment," ACGIH, 2012;
4. "Twelfth Annual Report on Carcinogens," NTP, 2011;
5. "Monographs," IARC, WHO;
6. SDSs for reproductive toxins and cancer causing substances (*http//www.ehs.uci.edu/msds.html*); and
7. "Chemicals Known to the State to Cause Cancer or Reproductive Toxicity" (Proposition 65), 22 CCR 12000.

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

D. Safety Data Sheets (SDS)

A SDS (formerly known as MSDS) must be available for each hazardous substance in a laboratory's chemical inventory. SDSs are available from the CSUSB online SDS library, available on the CSUSB EHS Website (*http://csusb.edu/ehs*). PIs/Laboratory Supervisors are responsible for SDSs current and making them available to all laboratory employees throughout the work day. SDSs must be in a central location that can accessed immediately in the event of an emergency. Electronic copies may be kept in 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 laboratory suite, require the preparation of an SDS for each synthesized substance. The Cal-State system wide SDS library has the capability of developing new SDSs based on the known chemical and physical properties of that substance. Contact EH&S, ext. 75179 for more information on preparing new SDSs.

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

1. **Identification of substance or mixture and of supplier**
   - GHS product identifier.
   - Other means of identification.
   - Recommended use of chemical or restrictions on use.
   - Supplier's details (including name, address, phone number, etc.).
   - Emergency phone number.
2. **Hazard Identification**
   - GHS classification of the substance/mixture and any national or regional information.
   - GHS label elements, including precautionary statements. (Hazards symbols may be provided as a graphical reproduction if the symbols in black and white or the name of the symbol, e.g., flame, skull and crossbones.) Symbols are required to be in a red border /red diamond.
   - Other hazards which do not result in classification (e.g., dust explosion hazard) are not covered by the GHS.
3. **Composition/information on ingredients**

- **Substance**
    - Chemical identity.
    - Common name, synonyms, etc.
    - CAS number, EC number, etc.
    - Impurities and stabilizing additives which are themselves classified and which contribute to the classification of the substance.
- **Mixture**
    - The chemical identity and concentration or concentration ranges of all ingredients which are hazardous within the meaning of the GHS and are present at or above their cutoff levels.

4. **First aid measures**
    - Description of necessary measures, subdivided according to the different routes of exposure, i.e., inhalation skin and eye contact, and ingestion
    - Most important symptoms/effects, acute and delayed.
    - Indication of immediate medical attention and special treatment needed, if necessary.
5. **Firefighting measures**
    - Suitable (and unsuitable) extinguishing media
    - Specific hazards arising from the chemical (e.g., nature of any hazardous combustion products).
    - Special protective equipment and precautions for firefighters.
6. **Accidental release measures**
    - Personal precautions, protective equipment, and emergency procedures.
    - Environmental precautions.
    - Methods and materials for containment and cleaning up.
7. **Handling and storage**
    - Precautions for safe handling.
    - Conditions for safe storage, including incompatibilities.
8. **Exposure controls/personal protection**
    - Control parameters, e.g., occupational exposure limit values or biological limit values.
    - Appropriate engineering controls.
    - Individual protection measures, such as personal protective equipment.
9. **Physical and chemical properties**
    - Appearance (physical state, color, etc.).
    - Odor**.**
    - Odor threshold.
    - pH.
    - Melting point/freezing point.
    - Initial boiling point and boiling range.
    - Flash point.
    - Evaporation rate.
    - Flammability (solid, gas).
    - Upper/lower flammability or explosive limits.
    - Vapor pressure.
    - Vapor density.
    - Relative density.
    - Solubility(ies).

- Partition coefficient: n-octanol/water.
- Auto-ignition temperature.
- Decomposition temperature.

10. Stability and reactivity

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

11. Toxicological information

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

12. Ecological information

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

13. Disposal considerations

- Description of waste residues and information on their safe handling and methods of disposal, including the disposal of any contaminated packaging.

14. Transport information

- UN Number.
- UN Proper shipping name.
- Transport Hazard class(es).
- Packing group, if applicable.
- Marine pollutant (Yes/No).
- Special precautions which a user needs to be aware of or needs to comply with in connection with transport or conveyance either within or outside their premises.

15. Regulatory information

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

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

1. Labels and Other Forms of Warning

Labelling requirements for all hazardous substances are summarized as follows:

- All containers of purchased hazardous materials or materials intended for distribution 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 and Proposition 65 warming 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 appropriate hazard warnings based on the knowledge of the chemicals and physical properties of that substance.
- New synthesized compounds must be labeled with employee's information and chemical name or structure if known or at a minimum a chemical identification number derived from the employee's lab-book.
- Global Harmonization System symbols should be used when labeling containers.

Additional information on container labelling is provided in *Appendix B*

2. 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)

3. Employee Information and Training

Employee training on specific workplace hazards must be provided at the time of initial assignment, whenever a new hazard is introduced into the workplace, and whenever employees may be exposed to hazards in other work areas. General Hazard Communication Training is available online through the Skillport Training Module (located in the MyCoyote website, https://my.csusb.edu/default/mycoyote/index, and by using your Coyote Credentials). The online Safety Training is not a substitution for the Laboratory Safety Fundamentals Concepts. Additional employee training is required whenever a new

hazard is introduced to the work environment, and must be provided within 30 days of receiving the SDS or other safety information and before the employee starts work with said new hazard. All training must be in appropriate language, education level, and vocabulary personnel. Employees must be given the opportunity to ask questions.

4. Laboratory Hazard Assessment Tool

The Laboratory Hazard Assessment Tool, found in the Risk and Safety Software (RSS) located on the MyCoyote website, https://my.csusb.edu/default/mycoyote/index, was developed to broadly identify activities involving chemical and other types of hazards and is an effective method of hazard communication. The Laboratory Assessment Tool captures information on the specific type of hazard(s), the location of 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.

5. Other Resources

1. "Occupational Exposure to Hazardous Chemicals in Laboratories." California Code of Regulations (CCR) Title 8, Section 5191;
2. Standard Operating Procedures (SOPs) for handling toxic chemicals (Appendix C);
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 CSUSB EH&S website for hazardous waste management information (http://csusb.edu/ehs);
    - 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 "CSUSB Injuries and Medical Treatment" poster (http://ehs.uci.edu/MedEmergPoster.pdf)
    - 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.
    - Report injury, illness, or safety concern online : https://csusb.edu/ehs/forms
    - Work related injury and illness information available online: https://csusb.edu/ehs/forms

III. Classes of Hazardous Chemicals

A. Regulatory Requirements for Classes of Hazardous Chemicals

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

- *Title 8, California Code of regulations (CCR), Section 5194, "Hazard Communication"*
- *Title 8, CCR, Section 5209, "Carcinogens"*

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

B. Identification and Classification of Hazardous Chemicals

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

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

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

1. Flammability Hazards

A number of highly flammable substances are in common use in the campus laboratories. Flammable liquids include those chemicals that have a flashpoint of less than 200 degrees Fahrenheit. These materials must be stored in self-closing flammable storage cabinets in aggregate quantities of 10 gallons or more per room. If less than 10 gallons, flammables can be stored in regular cabinets. Flame-resistant laboratory coats must be worn when working with large quantities (4 liters or more) of flammable materials and/or with procedures where significant fire risk s present. (e.g., when working with open flame, etc.). Even though the use of these materials is fairly common in the laboratory setting, they can constitute a significant immediate threat and should be treated with particular care. Particular attention should be given to preventing static electricity when handling flammable liquids.

- GHS Pictogram for Flammables

2. Reactivity Hazards

Reactive and explosive substances are materials that decompose under conditions of mechanical shock, elevated temperature, or chemical action, and release large volumes of gases and heat. Some materials such as peroxide formers, may not be explosive, but may form explosive substances over time. These substances pose an immediate potential hazard and procedures which use them must be carefully reviewed. These materials must also be stored in a separate flame-resistant storage cabinet or, in many cases, in a laboratory grade refrigerator or freezer that are designed for flammable and reactive chemicals. Peroxide formers can only be stored in refrigerators when unopened. Ones used have to be stored in a dry environment. Pyrophoric chemicals are a special classification of reactive materials that spontaneously combust when in contact with air

and require laboratory-specific training. Flame-resistant laboratory coats must always be worn when working with pyrophoric chemicals.

3. 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, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

- GHS Pictogram for Health Hazard

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

a. Corrosive Substances

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

- GHS Pictogram for Corrosive

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 that come in contact with and may be highly reactive with other substances. It is important to review information regarding materials they may corrode, and their reactivity with other substances, as well as information on health effects. In most

cases, these materials should be segregated from other chemicals and require secondary containment when in storage.

b. Irritants

Irritants are defined as a 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 cab include reddening or discomfort of the skin and irritation to respiratory systems.

1. 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 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
- Hematopoietic agents – e.g., carbon monoxide and cyanides which decrease hemoglobin function and deprive the body tissues of oxygen
- Pulmonary agents – e.g., asbestos and silica

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

- GHS Pictogram for Harmful/Irritant

4. Particular Hazardous Substances

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

a. **Hazardous chemicals**; and
b. **Particularly hazardous substances**

Substances that pose such significant threats to human health are classified as "particular hazardous substances" (PHSs). The OSHA Laboratory Standard and Cal/OSHA regulation require that special provisions be established to prebvent the harmful exposure of researchers to PHSs, including the establishment of designated areas for their use.

See Safe Use of Particularly Hazardous Substances (*Appendix D*) 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. **Acutely Toxic Chemicals**;
2. **Reproductive Toxins**; and
3. **Carcinogens**.

Acutely Toxic Chemicals
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 labelled as "Toxic." Empty containers of these substances must be packaged and disposed of as hazardous waste without rinsing trace amounts into the sanitary sewer system.

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

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

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

supervisor and EH&S before working with substances that are suspected to be reproductive toxins.

Carcinogens
Carcinogens are chemical or physical agents that cause cancer. Generally they are chronically toxic substances; that is, they cause damage after or long-duration exposure, and their effects may only become evident after a long latency period. Chronic toxins are particularly insidious because they may have no immediately apparent harmful effects. These materials are separated into two classes:

a. **Select Carcinogens**; and
b. **Regulated Carcinogens**.

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

- OSHA Carcinogen List
- Annual report on Carcinogens published by the National Toxicology Program (NTP), including all of the substances listed as "known to be carcinogens" and some substances listed as "reasonable anticipated to be carcinogens"
- International Agency for Research on Cancer (IARC), including all of Group 1 "carcinogen to humans" by the International Agency for Research on Cancer Monographs (IARC) (Volumes 1-48 and Supplements 1-8); and some in Group 2A or 2B, "reasonably anticipated to be carcinogens" by the National Toxicology Program (NTP), and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: (i) 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 $10mg/m^3$; (ii) after repeated skin application of less than 300 mg/kg of body weight per week; or (iii) after oral dosages of less than 50 mg/kg of body weight per day.

Regulated Carcinogens fall into a higher hazard class and have extensive additional requirements associated with them. The use of these agents may require personal exposure sampling based on usage. When working with Regulated Carcinogens, it is particularly important to review and effectively apply engineering and administrative safety controls as the regulatory requirements for laboratories that may exceed long term (8 hours) or short term (15 minutes) threshold values for these chemicals are very extensive.

Chemicals Known to the State of California to Cause Cancer or Reproductive Toxicity
The Safe Drinking Water and Toxic Enforcement Act of 1986, also known as **Proposition 65**, requires the State to publish a list of chemicals known to cause

cancer or reproductive toxicity (*http://eohha.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 (DART) Identification Committee.

5. Nanomaterials

The increasing use of nanomaterials in research laboratories 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 to 100 nm). Nanomaterials are bot 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 5.1).

Table 5.1 Types of Nanomaterials (from page 5 of Nanotoolkit)

Carbon Based	**Buckyballs or Fullerenes, Carbon Nanotubes*, Dendrimers** *Often include functional groups like * PEG (polyethylene glycol), Pyrrolidine, N, N-Dimethylenediamine, 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, 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 (Table 5.2). In general, the risk of exposure is lowest when nanomaterials are bound in a solid matrix with little potential to create airborne dust or when in a non-volatile solvents or liquids. 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 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 nanomaterial).

See https://www.ehs.uci.edu/programs/sop_library/nanotoolkit.pdf for a detailed Standard Operating Procedures (SOP) template for working with nanomaterials that provides guidance on appropriate work practices, engineering controls, Personal Protective Equipment (PPE), and waste disposal practices depending on the risk level of a particular nanomaterial or process involving a nanomaterial.

For further information see the California Nanosafety Consortium of Higher Education's "Nanotoolkit Working Safely with Engineered Nanomaterials in Academic Research Settings" (http://www.ehs.ucr.edu/laboratory/nanotoolkit.pdf),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 5.2 Nanomaterial Risk Categories (from page 10 of Nanotoolkit)

Category 1 Lower Exposure Potential	**Material State** • No potential for airborne release (when handling) • Solid: bound in a substrate or matrix • Liquid: water-based liquid suspensions or gels • Gas: No potential for release into air (when handling) **Type of use** • No thermal or mechanical stress	• Non-destructive handling of solid engineered 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) **Types 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 dust collection systems used to capture nanomaterials • High speed abrading/grinding nanocomposite materials

IV. How to reduce Exposures to Hazardous Chemicals

A. Regulatory Requirements for Exposures to Hazardous Chemicals

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

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

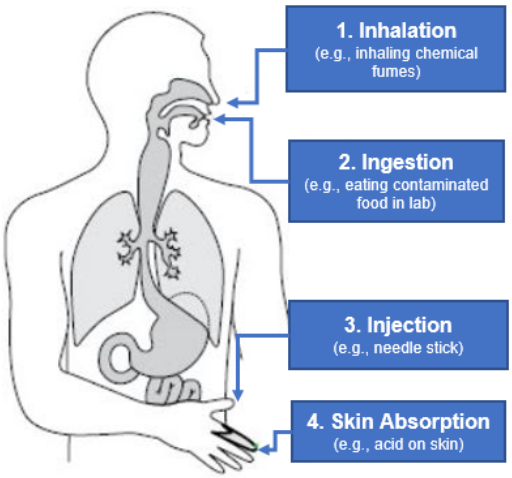
Other applications regulations include those promulgated by the U.S. Department of Labor including CFR 1910.1450 "Occupational exposure to Hazardous Chemicals in Laboratories" (the "Laboratory Standard").

B. Introduction

Hazardous chemicals require a carefully multi-tiered approach to ensure safety. There are four primary routes of exposure for chemicals which have associated health hazards (illustrated in Figure 4.1):

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

Figure 4.1: Routes of Exposure



Of these, the most likely route of exposure in the laboratory is by inhalation. Many hazardous chemicals may be affected 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.

C. 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.

D. 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.

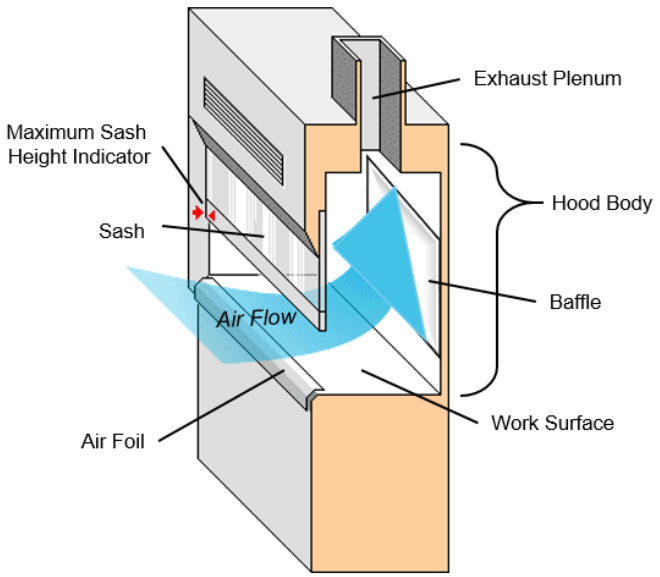
1. General Laboratory Ventilation

All laboratory rooms in which hazardous materials are used must 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.

2. 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, which ever us higher. Figure 4.2 displays the key components of a fume hood.

Figure 4.2: Standard Fume Hood Components



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

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

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

Each fume hood must be equipped with at least one type of continuous quantitative monitoring device designed to provide the user with current information on the operational status of the hood. Many hoods also have motion sensors to determine when they are not in active use. These sensors will reduce the fume hood's air flow as

part of the campus' energy saving effort. When hazardous materials are in a fume hood, but it is not under active use (e.g., during an unattended reaction or equipment), the sash should be closed. Fume hoods are not designed for storage of hazardous materials.

Routine maintenance and repairs of fume hoods are conducted by Facilities Management and/or Heating and Air Conditioning. However, in most cases, the fume hood must be cleared by the Primary Investigator (PI) and/or the Laboratory Supervisor prior to commencement of repairs. The user may initiate the need for maintenance or repairs by requesting a Work Order be made calling Work Control in Facilities Management (ext. 75175). EH&S does not initiate maintenance but will coordinate with Facilities Management to ensure its completion. An electronic notification is generated by Facilities Management aster the work order is completed.

1. **General Rules for Fume Hood Use**

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

   - Fume hoods must not be used for work involving hazardous substance unless they have a certification label that confirms certification has occurred with the past year;
   - Always keep hazardous chemicals more than **six inches** behind the place of the sash;
   - **Never** put your head inside an operating laboratory hood. The plane of the sash is the barrier between contaminated and uncontaminated air;
   - 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;
   - Do not clutter you hood with unnecessary bottles or equipment that can block air circulation. Keep it clean and clear. Only materials actively in use should be in the hood;
   - Do not make any modifications to hoods, duct work, or the exhaust system without first contacting the EH&S Department.
   - Do not use large equipment in laboratory hoods unless the hood is dedicated for this purpose, as large obstructions can change the airflow patterns and render the hood unsafe;
   - **Shut your sash**! For energy efficiency, make sure to shut your sash when the hood is not in use.

2. **Fume Hood Inspections**

   Laboratory fume hoods are one of the most important pieces of equipment used to protect laboratory and other workers from exposures 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 have additional requirements, such as increase face velocity (average of 150 fpm, with no measurement less than 100 fpm), contact the EH&S Department at your campus is the intended use changes.

   Table 4.1 lists a general guideline that should be followed when conducting a fume hood inspection:

Table 4.1: Fume Hood Inspections Guideline	
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: o Improper storage of materials inside the fume hood; o Use of proper materials; o General hood cleanliness; o Physical damage to the fume hood (e.g., broken or cracked sash); o 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: o 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; o Noise generated by the fume hood, to ensure that it is below 85 dB; o If fume hood does not pass inspection, the yellow inspection tag will state “FAIL” on it.

3. 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.

4. Other Engineering Controls

In addition to the elements listed above, consideration mist 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 mist be kept in explosion proof refrigeration units specifically designed for storing these materials. Generally these unit do not have internal lights or electronic systems that 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 (UL) or other certifying organization.

Secondary containment must be provided for corrosive and reactive chemicals and is recommended for all other hazardous chemicals. Secondary containment should be made of chemically resistant materials and should be sufficient to hold 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 handwashing to remove any final residual contamination. Handwashing 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.

E. Administrative Controls

The nest layer of safety controls are 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 communicate via lab specific trainings, Standard Operating Procedure (SOP) or Job Safety Analysis, and proper documentation.

1. Standard Operating Procedures

Standard Operating Procedures (SOPs) (Appendix C) or Job Safety Analysis (JSAs) that are relevant to safety and health consideration must be developed and followed when laboratory work involves the use of hazardous chemicals (CCR, Title 8, Section 5191 (e)(3)(A)), especially for “particularly hazardous substances” (PHS). SOPs are written instructions that detail steps that will be performed during a given experimental procedure and include information about potential hazards and hoe these hazards will be mitigated. SOPs should be written by Primary Investigator (PI) and/or Laboratory Supervisor who are the most knowledgeable and involved with the experimental process. The development and implementation of SOPs is a core component of promoting a strong safety culture in the laboratory and helps ensure a safe work environment.

While general guidance regarding laboratory work with chemicals is contained in this plan, PIs/Laboratory Supervisors are required to develop and implement laboratory-specific SOPs for certain hazardous chemicals and PHS that are used in their laboratories. 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. 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.

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

EH&S is also available to assist with the development of SOPs. SOPs must be developed prior to initiating any experiments with hazardous chemicals or PHS and are to be filed and maintained in the Laboratory Safety Binder where they are available to all laboratory personnel.

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

2. Protective Apparel and Equipment

a. Personal Protective Equipment

Personal protective equipment (PPE) serves as a researcher's last line of defense against chemical exposures and is required by everyone entering a laboratory containing hazardous chemicals. Specific minimum requirements for PPE use, for chemical operations, should be determined based on manufacturer's Safety Data Sheets (SDSs) recommendations.

The basic PPE requirements, which include but are not limited to:

- Full length pants and close-toed shoes, or equivalent;
- Protective gloves, laboratory coats, and eye protection when working with, or adjacent to, hazardous chemicals;
- Flame resistant laboratory coats for high hazard materials, pyrophorics, and more than 4 liters of flammables or any amount of flammables in the presence of ignition source.

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.

b. 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.

c. Contaminated Clothing/PPE

In cases where spills or splashes of hazardous chemicals on clothing or PPE occur, the clothing/PPE should immediately be removed and placed in a closed container that prevents release of the chemical. Heavily contaminated clothing/PPE resulting from an accidental spill should be disposed of as hazardous

waste. Non-heavily contaminated laboratory coats should be cleaned and properly laundered, according to manufacturer's recommendation. Laboratory personnel should never take contaminated items home for cleaning or laundering. A washing machine located in the Animal House is available for your convenience to launder any non-heavily contaminated laboratory coats. 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.

d. Respiratory Protection

Typically, respiratory protection is not needed in a laboratory. Under most circumstances, safe work practices, small scale usage, and engineering controls (fume hoods, biosafety cabinets, and general ventilation) adequately protect laboratory workers from chemical 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;
- If an individual has developed a sensitivity/allergy to specific chemicals.

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 (Appendix E), review it with his/her PI/Laboratory Supervisor, and email to **ehs@csusb.edu**. 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 CSUSB'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. 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 licensed health care professional 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 licensed health care professional 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 include/exclude;
- 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 CSUSB's Respiratory Protection Program, Medical Monitoring Program, and Cal/OSHA regulations (8 CCR 5144).

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.

5. 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.

1. Fire Extinguishers

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 fire extinguisher 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 EH&S ext. 75179.

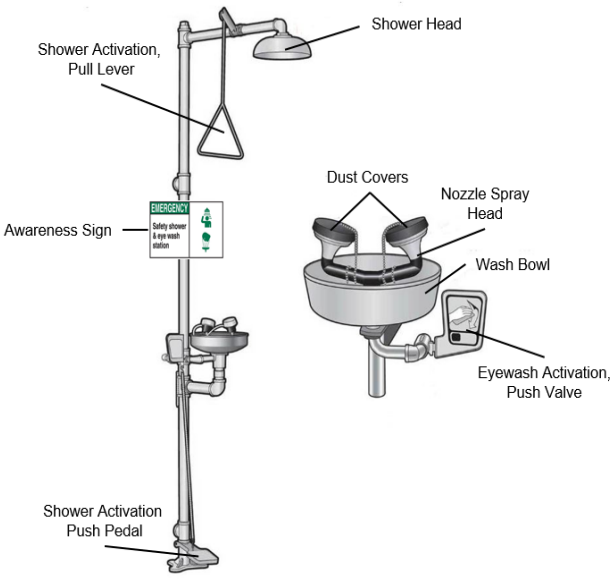
2. Safety Showers and Eyewash Stations

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. Figure 4.3 illustrates the basic components of safety shower and eyewash station. Additionally, keg-type

shower/eyewash systems are only acceptable as a temporary solution and are not intended to replace emergency safety showers/eyewash stations.

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.

Figure 4.3: Basic Components of Safety Shower and Eyewash Station



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 EH&S. If an eyewash or safety shower needs repair, call Facilities Management Work Control ext. 75175 and give the administrative coordinator the specific location of the defective equipment. Facilities Work Control Services Requests 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 Work Control Services Requests.

3. **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.

6. 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:

1. **Personal protective Equipment:**
   - Wear closed-toe and closed-heel shoes and full length pants, or equivalent, at all times when in the laboratory;
   - Utilize appropriate PPE while in the laboratory and while performing procedures that involve the use of hazardous chemicals or materials;
   - Confine long hair, loose clothing, and accessories;

- Remove laboratory coats or gloves immediately on significant contamination, as well as before leaving the laboratory;
- Avoid use of contact lenses in the laboratory unless necessary. If they are used, inform supervisor so special precautions can be taken;
- 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 station;
- Change gloves often while working with chemicals and wash hands after completing experimental and/or laboratory work before leaving the laboratory to further remove any unwanted contamination.

2. **Chemical Handling:**
    - Properly label and store all chemicals. Use secondary containment at all times;
    - Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan;
    - Do not smell or taste chemicals;
    - Never use mouth suction for pipetting or starting a siphon;
    - Do not dispose of any hazardous chemicals through the sewer system;
    - Be prepared for an accident or spill and refer to the emergency response procedures for the specific material. Procedures should be readily available to all personnel. Information on minor chemical spill mitigation may also be referenced in Appendix I. 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 (15 minutes) and remove any contaminated clothing. If symptoms persist after washing, seek medical attention.

3. **Equipment Storage and Handling:**
    - Store laboratory glassware with care to avoid damage. Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur;
    - Use certified fume hoods, glove boxes, or other ventilation devices for operations which might result in release of toxic chemical vapors or dust. Preventing the escape of these types of materials into the working atmosphere is one of the best ways to prevent exposure;
    - Keep hood sash closed when you are not working in the hood;
    - Do not use damaged glassware or other equipment;
    - Do not use uncertified fume hoods or glove boxes for hazardous chemical handling;
    - Avoid storing materials in hoods;
    - Do not allow the vents or air flow to be blocked.

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

5. **Food/Drink:**
    - Do not eat, drink, smoke, chew gum, or apply cosmetics (including chapsticks/lipbalms) in areas where laboratory chemicals are present; wash hands before conducting these activities;
    - Do not store, handle, or consume food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations;
    - Wash areas of exposed skin well before leaving the laboratory to prevent the spread of chemical contamination.

V. Chemical Exposure Assessment

A. Regulatory Requirements for Chemical Exposure Assessment

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

Cal/OSHA regulates Permissible Exposure Limits (PELs) for airborne contaminants to which "*nearly all workers may be exposed daily during a 40-hour workweek for a working lifetime (of 40 years) without adverse effect*", and are based upon an 8-hour Time-Weighted Average (TWA) exposure. Thus, the PELs are the maximum permitted 8-hour TWA concentration of an airborne contaminant without the use of respiratory protection. Cal/OSHA has also defined Short Term Exposure Limits (STELs) as the maximum TWA exposure during any 15 minute period, provided the daily PEL 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. 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.

B. Exposure Assessment Overview

All Cal State 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.

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. Based on chemical inventories, review of Standard Operating Procedures (SOPs), types of engineering controls present, laboratory inspection results and/or review of the annual Laboratory Hazard Assessment Tool, EH&S determines whether an exposure assessment is warranted; 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 chemical through double needle performed entirely in a fume hood) and the potential for exposure exists. The user should then inform his or her PI/Laboratory Supervisor, who will in turn contact EH&S for further instruction. EH&S will then determine the best course of action in assessing employee exposure, including visual assessment, air monitoring, medical evaluation, examination, or medical surveillance.

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

C. Exposure Assessment Protocol—Notification to Employees or Employee Representative and Right to Observe Monitoring (Section 340.1)

The EH&S Department conducts exposure assessments for members of the campus community. Employees have a right to observe testing, sampling, monitoring or measuring of employee exposure. They are also allowed access to the records and reports related to the exposure assessment. Exposure assessments may be performed for hazardous chemicals, as well as for physical hazards including noise and heat stress to determine if exposures are within PELs or other appropriate exposure limits that are considered safe for

routine occupational exposure. 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. Evaluation of 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 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, CSUSB 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 and the University's Respiratory Protection Program.

In assessing exposure to hazardous chemicals for which Cal/OSHA has not published a PEL, STEL or Ceiling exposure, EH&S defers to the Threshold Limit Values (TLVs) established by the American Conference of Governmental Industrial Hygienists (ACGIH) or the Recommended Exposure Limits (RELs) established by the National Institute of Occupational Safety & Health (NIOSH). Please contact EH&S, ext. 75179 for more information regarding these chemicals.

D. Notification

EH&S will promptly notify the employee and their PI/Laboratory Supervisor of the results in writing (within 15 working days or less if required) after the receipt of any monitoring results. EH&S will establish and maintain an accurate record of any measurements taken to monitor exposures for each employee. Records, including monitoring provided by qualified vendors, will be managed in accordance with CCR Title 8 Section 3204 "Access to Employee Exposure and Medical Records."

E. Exposure Assessment Use to Determine and Implement Controls

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

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," the control of harmful exposures shall be prevented by implementation of control measures in the following order:

- Engineering controls, whenever feasible;
- Administrative controls whenever engineering controls are not feasible or do not achieve full compliance and administrative controls are practical; and
- Personal protective equipment, including respiratory protection, during:
    - the time period necessary to install or implement feasible engineering controls;
    - when engineering and administrative controls fail to achieve full compliance;
    - in emergencies;
    - as an extra precaution/option for employees.

1. Medical Evaluation

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

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which an employee may have been exposed in a laboratory;
- 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;
- 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
- Upon reasonable request of the employee to discuss medical issues and health concerns regarding work-related exposure to hazardous chemicals.

All work-related medical evaluations and examinations will be performed by 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 or student worker who exhibits signs and symptoms of adverse health effects from work-related exposure to a hazardous chemical should report immediately for a medical evaluation.

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

2. Information to Provide to the Clinician

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

- Personal information such as age, weight, and campus employee ID number;
- Common and/or IUPAC name of the hazardous chemicals to which the individual may have been exposed;
- A description of the conditions under which the exposure occurred;
- Quantitative exposure data, if available;
- A description of the signs and symptoms of exposure that the employee is experiencing, if any;
- A copy of the Safety Data Sheet (SDS) of the hazardous chemical in question;
- History of exposure including previous employment and non-occupational (recreational) hobbies; and
- Any additional information helpful in assessing or treating an exposure or injury such as a biological component of exposure or existence of an antitoxin.

3. 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:

- Recommendation for further medical follow-up;
- Results of the medical examination and any associated tests, if requested by the employee;
- 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
- 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.

4. Confidentiality and Individual's Access to Personal Medical Records

All patient medical information is protected by California and federal law and is considered strictly confidential. The examining physician is prohibited from disclosing any patient medical information that is not directly related to the work-related exposure under evaluation and should not reveal any diagnosis unrelated to exposure. Any patient information disclosed by the examining physician to the employee's supervisor will be limited to information necessary in assessing an employee's return to work, including recommended restrictions in work activities, if any. Any patient information disclosed by the examining physician to EH&S will be limited to information necessary to develop a course of exposure monitoring, or perform hazard assessments and incident investigations, if appropriate. The examining physician will otherwise disclose patient medical information only as required by California and Federal law, such as for Worker's Compensation Insurance claims. Each employee has the right to access his/her own personal medical and exposure records. The examining physician will provide an employee with a copy of his/her medical records upon written request.

5. 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.

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 and not limited to:

- Asbestos
- Beryllium
- Formaldehyde
- Lead
- Methylene Chloride
- Noise (Hearing Conservation Program)
- Radioactive Chemicals (Radiation Safety Program)
- Respirator Use (Respirator Protection Program)
- Other Particularly Hazardous Substances

Individuals with questions regarding work-related medical surveillance are encouraged to contact EH&S at ext. 75179 for more information.

VI. Inventory, Labeling, Storage, and Transport

A. Regulatory Requirements for Inventory, Labeling, Storage, and Transport of Chemicals

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

- Title 8, California Code of Regulations (CCR), Section 5164, “Storage of Hazardous Materials”;
- Title 8, California Code of Regulations (CCR), Section 5191, “Occupational Exposures to Hazardous Chemicals in Laboratories”;
- Title 8, California Code of Regulations (CCR), Section 5194, “Hazard Communication”;
- Title 8, CCR, Section 5209, “Carcinogens”;
- Title 8, CCR, Section 5154.1, “Ventilation Requirements for Laboratory-Type Hood Operations”;
- Assembly Bill 2286

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

B. 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. Specific storage locations must be kept as part of the inventory list to ensure that they can be easily located. Chemical inventories are used to ensure compliance with storage limits and fire 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 Sheet (SDS) for that chemical. 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 controlled substances. For guidance on locked storage requirements, please contact EH&S, ext. 75179.

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.

Cal/OSHA Title 8 Section 5194 (e) (1) 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 mandates the development of the California Environmental Reporting System (CERS) 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 maintain an up-to-date chemical inventory.

C. 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 using the Globally Harmonized System (GHS) 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 waste in one year. These chemicals can degrade to form shock sensitive, highly reactive compounds and should be stored and labeled very carefully.

Particularly Hazardous Substances (see Section 3) require additional labeling to identify the specific hazard associated with each of these chemicals (carcinogen, reproductive toxin, acutely toxicant). In addition, the storage area where they are kept must be labeled with the type of hazard. These chemicals should be segregated from less hazardous chemicals to help with proper access control and hazard identification.

D. Chemical Storage and Segregation

Establish and follow safe chemical storage and 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. Always wear appropriate personal protective equipment (e.g., laboratory coat, safety glasses, gloves, safety goggles, apron, etc.) when handling hazardous chemicals. Be aware of the locations of the safety showers and emergency eyewash stations. Each laboratory is required to provide appropriate laboratory-specific training on how to use this equipment **prior** to working with hazardous chemicals. Table 6.1 lists chemical safety storage priorities.

Table 6.1 – Chemical Safety Storage Priorities

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

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

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

E. General Recommendations for Safe Storage and Segregation 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 will seriously impair the ventilating capacity of the hood. Chemicals should not be routinely stored on bench tops or stored on the floor. Additionally, bulk quantities of chemicals (i.e., larger than one-gallon) should be stored in a separate storage area, such as a stockroom or supply room.

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

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

Laboratory refrigerators and freezers must be labeled appropriately with “No Food/Drink” and must **never** be used for the storage of consumables. Freezers should be defrosted periodically so that chemicals do not become trapped in ice formations. **Never** store opened peroxide formers (e.g., ether) in a refrigerator or freezer! In regards to segregation of chemicals three comprehensive tables were created in order to assist researchers with specific chemical incompatibilities. These tables can be found in Appendix H.

F. Flammable and Combustible Liquids

In general flammables should not be stored alongside combustible materials like paper and packaging nylon bags. Large quantities of flammable or combustible chemicals 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 per room**. Only the amounts needed for the current procedure should be kept on bench tops and the remainder should be kept in flammable storage cabinets, explosion proof 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 and should not be stored in a refrigerator/freezer if the chemical has a flash point below the temperature of the equipment. Flammable or combustible liquids must not be stored on the floor or in any exit access.

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

G. Pyrophoric and 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 manufacturer's SDS. Reactive materials containers must be clearly labeled with the correct chemical name, in English, along with a hazard warning.

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

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

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

1. Dry any new empty containers thoroughly;
2. Insert the septum into the neck in a way that prevents atmosphere from entering the clean dry (or reagent filled) flask;
3. Insert a needle to vent the flask and quickly inject inert gas through a second needle to maintain a blanket of dry inert gas above the reagent;
4. Once the vessel is fully purged with inert gas, remove the vent needle then the gas line. To introduce the excess chemical, use the procedure described in the handling section, below;
5. For long-term storage, the septum should be secured with a copper wire;
6. For extra protection a second same-sized septa (sans holes) can be placed over the first; and

7. Use parafilm around the outer septa and remove the parafilm and outer septum before accessing the reagent through the primary septum.

The EH&S document titled “Safe use of Pyrophoric Reagents” (Appendix G) and Safety video (through Skillport) provide information about the safe handling of pyrophoric chemicals.

H. Oxidizers

Oxidizers (e.g., hydrogen peroxide, ferric chloride, 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.

I. Peroxide Forming Chemicals

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). The containers should be labeled with the date received and the date opened. This information, along with the chemical identity should face forward to minimize container handling during inspection. These chemicals should also be tested and documented for the presence of peroxides periodically. Minimize the quantity of peroxide forming chemicals stored in the laboratory and dispose of peroxide forming chemicals before peroxide formation. Refer to Appendix F for specific guidelines and/or contact EH&S, ext. 75179 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, (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 EH&S, ext. 75179 for pick-up and disposal.

J. Corrosives

Store corrosive chemicals (i.e., acids, bases) below shoulder 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).

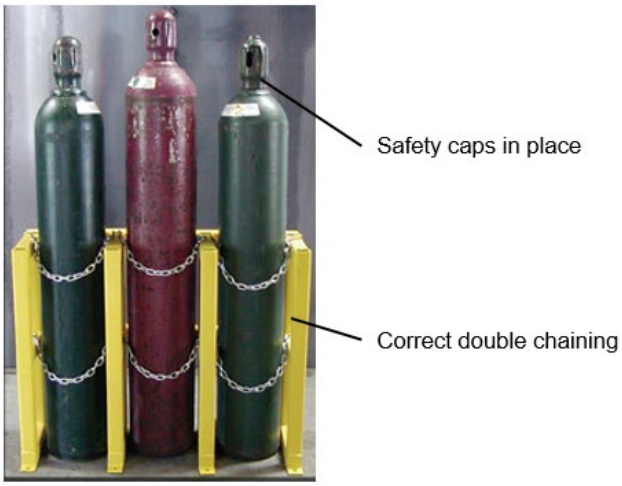
Specific types of acids require additional segregation. Mineral acids should be kept away from organic acids and oxidizing acids must be segregated from organic compounds, flammable and combustible substances. Perchloric acid and hydrofluoric acid should be stored by themselves, away from other chemicals.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

K. Special Storage Requirements

1. Compressed Gases and Toxic Gases

Compressed gas cylinders that are stored in the laboratory must be chained to the wall, with the safety cap in place. The cylinders must be restrained by two chains; one chain must be placed at one third from the top of the cylinder, and the other placed at one third from the bottom of the cylinder (see Figure 6.1). 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 which contain a water volume of more than 5 liters**. Do not expose cylinders to excessive dampness, corrosive chemicals or fumes.

Figure 6.1: Cylinders Stored and Chained Correctly



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

Gas cylinder connections must be inspected frequently for deterioration and must never be used without a regulator. Never use a leaking, corroded or damaged cylinder and never refill compressed gas cylinders. When stopping a leak between cylinder and regulator, always close the valve before tightening the union nut. The regulator must be replaced with a safety cap when the cylinder is not in use. When moving gas cylinders, verify first that the safety cap is in place and only use carts designed for this purpose.

2. 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. Always use appropriate thermally insulated gloves when handling liquid nitrogen. Face shields may be needed in cases where splashing can occur.

L. Laboratory Security

Recently regulatory agencies have been implementing rules to ensure chemical security. While many of these rules are for large manufacturing facilities, it is critical that chemicals be secured to prevent theft from campus laboratories. Numerous federal agencies are involved in the maintenance of laboratory security, including the Drug Enforcement Agency, Federal Bureau of Investigations, and Department of Homeland Security. It is each laboratory's responsibility to prevent and report any theft of chemicals from their laboratory. Laboratories

are encouraged to conduct a Security Value Assessment (SVA). Aspects that should be covered in a SVA include:

- Existing threats, based on the history of the institution (e.g., theft of laboratory materials, sabotage, data security breaches, protests);
- The attractiveness of the institution as a target, and the potential impact of an incident;
- Chemicals, biological agents, radioactive materials, or other laboratory equipment or materials with dual-use potential;
- Sensitive data or computerized systems;
- Animal care facilities;
- Infrastructure vulnerabilities (e.g., accessible power lines, poor lighting);
- Security systems in place (e.g., access control, cameras, intrusion detection);
- Access controls for laboratory personnel (e.g., background checks, authorization procedures, badges, key controls, escorted access);
- Institutional procedures and culture (e.g., tailgating, open laboratories, no questioning of visitors);
- Security plans in place; 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 CSUSB Campus Police at ext. 77777 and CSUSB EH&S at ext. 75179.

M. On-Campus Distribution of Hazardous Chemicals

Precautions must be taken when transporting hazardous substances between laboratories and between buildings within the campus. 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. In the case of big quantities or more than one chemicals being transported the appropriate cart with build-in secondary containment should be utilized and high traffic areas need to be avoided.

Table 6.2: Correct Cylinder Transport

When transporting cylinders of compressed gases, always secure the cylinder with straps or chains onto a suitable hand truck and protect the valve with a cover cap. Avoid dragging, sliding, or rolling cylinders and use a freight elevator when possible. Figure 6.2 illustrates correct cylinder transport.

N. 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. CSUSB 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.

VII. Training

- **Regulatory Requirements for Training**
  Implementation of the necessary work practices, procedures, and policies outlined in this chapter is required by the following:

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

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

- **Introduction**
  Effective training is critical to facilitate a safe and healthy work environment and prevent laboratory accidents. All PIs/Laboratory Supervisors must participate in formal safety training and ensure that all their employees have appropriate safety training before working in a laboratory. EH&S provides both classroom and online training to help meet this requirement on the CSUSB MyCoyote Training Skillport website at https://my.csusb.edu/default/mycoyote/index .

- **Types of Training**
  All laboratory personnel must complete general laboratory safety training and lab specific training before:

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

  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 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 Section 3204 regarding access to employee exposure and medical records (annually required).

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

- CSUSB Laboratory Safety Fundamentals – for anyone working in a laboratory;
- CSUSB Hazard Communication and Globally Harmonized System – for anyone working in a laboratory;
- Hazardous waste – for anyone working in a laboratory creating waste (biological, chemical, radiological).

E. Laboratory Specific Training

PIs/Laboratory Supervisors must provide laboratory-specific training to their employees prior to working in the laboratory. Topics that require specific training include but are not limited to:

- 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;
- Specialized procedures and protocols;
- Particularly Hazardous Substances including physical and health hazards, potential exposure, medical surveillance, and emergency procedures;
- It is a California State University 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.

F. Resources

EH&S has a number of tools available for laboratories to simplify the completion of appropriate training, including but not limited to the following:

- Online training modules (http://www.uclc.uci.edu/). Completing the Training SelfAssessment will provide a complete list of available training courses.
    - UC Laboratory Safety Fundamentals;
    - Bloodborne Pathogens;
    - Chemical Fume Hood;
    - Chemical Hygiene/Laboratory Safety
    - Fire Extinguisher Safety;

- Formaldehyde Safety;
- Hazard Communication and General saftey;
- Hazardous Waste;
- Respiratory Protection
- Waste Management

- Standard Operating Procedures
  - Chemical Specific SOPs;
  - Banded SOPs;
  - Process specific SOPs;
  - Pyrophoric Reagents SOP and Pyrophoric Safety (Video).

EH&S provides additional assistance in planning laboratory-specific training upon request.

G. 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 laboratory specific training, and classroom and online training. Documentation should be maintained in the Laboratory Safety Binder.

The CSUSB Skillport website through MyCoyote https://my.csusb.edu/default/mycoyote/index documents training history for all courses completed online.

VIII. Inspections and Compliance

- **Regulatory Requirements for Inspections and Compliance**

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

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

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

- **Laboratory Safety Inspections**

EH&S has a comprehensive laboratory 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 CSUSB's commitment to protecting the health and safety of the campus community.

As part of this laboratory safety program, EH&S conducts periodic inspections of laboratories and other facilities with hazardous chemicals to ensure the laboratory is operating in a safe manner and to ensure compliance with all federal, state and university safety requirements. The primary goal of inspection is to identify both existing and potential accident-causing hazards, actions, faulty operations and procedures that can be corrected before an accident occurs. CSUSB policy 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 laboratory 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. Specific inspection compliance categories include:

1. Documentation and Training;
2. Hazard Communication (including review of SOPs);
3. Emergency and Safety Information;
4. Fire Safety;
5. General Safety;
6. Use of personal protective equipment (PPE);
7. Housekeeping;
8. Chemical Storage;
9. Fume Hoods;
10. Chemical Waste Disposal and Transport;
11. Seismic Safety; and
12. Mechanical and Electrical Safety.

Planned, focused assessments are also conducted. Examples of these include industrial hygiene assessments and unannounced PPE inspections. Once the inspection is completed, EH&S issues a Laboratory Inspection Report via email. The report identifies deficiencies in the laboratory, both critical and non-critical. Critical deficiencies are those that have the potential to lead to serious injuries or be of critical importance in the event of an emergency. These deficiencies must be immediately corrected. Non-critical deficiencies must be corrected within 30-days. Any deficiency that requires a "Facilities Management Work Order Request" for completion will be added to the Work Order database so that it can be expedited by Facilities Management. A copy of the most recent *Laboratory Inspection Report* should be maintained as part of the records inside the **Laboratory Safety Binder**.

- **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. Critical deficiencies are required to be corrected within 48-hours; non-critical deficiencies must be corrected within 30-days. Failure to take corrective actions within the required timeframe will result to a repeat violation and a 45 day follow-up will be completed by the department coordinator who will intervene in order to mitigate the identified deficiencies.

- **Recordkeeping Requirements**
  Accurate recordkeeping demonstrates a commitment to the safety and health of the California State University 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 (5 years);
  2. Laboratory Inspections records (5 years);

3. Training records (3 years);
4. Measurements taken to monitor employee exposures (30 years);
5. Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations;
6. Inventory and usage records for high-risk substances should be kept;
7. Any medical consultation and examinations, including tests or written opinions required by CCR, Title 8, Section 5191 (duration of employment plus 30 years);
8. Medical records must be retained in accordance with the requirements of state and federal regulations (duration of employment plus 30 years).

IX. Hazardous Chemical Waste Management

A. Regulation of Hazardous Waste

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

B. Hazardous Waste Program

The EH&S Hazardous Waste Program manages the shipment and disposal of all hazardous waste generated on campus. Each laboratory employee must comply with the campus Hazardous Waste Management Program requirements and all applicable regulations. Hazardous waste pick-up service is provided to all CSUSB hazardous waste generators. Laboratory personnel are responsible for identifying hazardous waste, segregating, labeling, and storing it properly in the laboratory. Laboratory clean-outs and disposal of high hazard compounds must be scheduled in advance. The PI/Laboratory Supervisor is responsible for coordinating the disposal of all chemicals from his/her laboratories prior to closing down laboratory operations.

1. Definition of Hazardous Waste

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

- Ignitable
    - Flashpoint <140 °F;
    - Capable of causing fire at standard temperature and pressure through friction, absorption of moisture, or spontaneous chemical changes;
    - Is an ignitable compressed gas;
    - Is an oxidizer;
- Corrosive
    - Liquid with pH less than or equal to 2 or greater than or equal to 12.5;
    - Solid with pH less than or equal to 2 or greater than or equal to 12.5 when mixed with equal weight of water;
- Reactive
    - Normally unstable and readily undergoes violent change;
    - Reacts violently with water or air;
    - Forms potentially explosive mixtures with water;

- Forms toxic gases, vapors or fumes when mixed with water
- Is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors, or fumes;
- Is capable of detonation or explosive decomposition if subjected to a strong initiating source or heated under confinement;
- Is readily capable of detonation or reaction at standard temperature and pressure;

- Toxic
  - Has an acute oral LD50 less than 2,500 mg/kg;
  - Has an acute dermal LD50 less than 4,300 mg/kg ;
  - Has an acute inhalation LC50 less than 10,000 ppm as a gas or vapor;
  - Has an acute aquatic 96-hour LC50 less than 500 mg/l;
  - Has been shown through experience or testing to pose a hazard to human health or environment because of its ability to cause cancer or mutations (carcinogen, mutagen, teratogen), acute toxicity, chronic toxicity, bio-accumulative properties, or persistence in the environment.

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

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

2. Extremely Hazardous Waste

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

C. Proper Hazardous Waste Management

1. Training

All personnel who are responsible for handling, managing or disposing of hazardous waste must attend training prior to working with these materials. The EH&S online Hazardous Waste training course covers the hazardous waste program requirements and includes training on container labeling. To complete Hazardous Waste training, log on to the Skillport through the MyCoyote website using your Coyote ID and password.

2. 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 Waste 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.

3. Labeling

Hazardous waste labels must be placed on the hazardous waste container upon the start of accumulation. Labels are available by contacting EH&S or the Hazardous Waste Manager. Each label must be completed accurately, and updated as the contents of the waste container change. Product names or abbreviations for waste container ingredients should not be used. Ensure that the label is clearly displayed so that the risk of incompatibles is lessened.

4. 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:

- Hazardous waste must be disposed of via EH&S within 6 months of being generated.
- Hazardous waste containers must be stored in secondary containment to adequately contain all of the contents of the container.
- Hazardous waste containers must be kept closed, except when adding waste.
- Hazardous waste that meets the quantity threshold of 55 gallons of hazardous waste or 1 quart of **acutely/extremely hazardous waste** must be disposed of within 3 days of reaching these set volumes.
- Report damaged containers to EH&S. EH&S can provide assistance to transfer the contents of the damaged container to an appropriate container.
- Containers must be inspected weekly for signs of leaks, corrosion, or deterioration.
- Do not dispose of chemicals by pouring them down the drain or placing them in the trash.
- Do not use fume hoods to evaporate chemicals.
- Hazardous waste streams must have compatible constituents, and must be compatible with the containers that they are stored in.

5. Segregation

All hazardous waste must be segregated to prevent incompatible mixtures. Segregation can be by hazard class. Hazard class examples include: Flammable, Oxidizer, Pyrophoric, Reactive, Reducer, Acid, Base, and Toxic Examples of proper segregation are:

- Segregate acids from bases;
- Segregate oxidizers from organic compounds;
- Segregate cyanides from acids;

For more information on specific chemical incompatibility, consult a safety data sheet (SDS).

6. 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 labels 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 that 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.

7. Waste That Requires Special Handling

a. 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”.

b. Peroxide Forming Chemicals

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

Each container of peroxide forming chemicals should be dated with the date received and the date first opened. There are three classes of peroxide forming chemicals, with each class having different management guidelines. A guide to managing some PFCs commonly found in research labs is provided in Appendix F. Since this Appendix does not provide an exhaustive list of PFCs, review the safety information/SDS provided by the manufacturer for any chemicals you purchase.

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 EH&S, ext. 75179 for pick-up and disposal.

c. Dry Picric Acid

Picric acid (also known as trinitrophenol) must be kept hydrated with deionized water 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 deionized water as needed to maintain a consistent liquid volume.

If old or previously unaccounted for bottles of picric acid are discovered, **do not touch the container**. Depending on how long the bottle has been abandoned and the state of the product inside, even a minor disturbance could be dangerous. Visually inspect the contents of the bottle without moving it to evaluate its water content and look for signs of crystallization inside the bottle and around the lid. If there is even the slightest indication of crystallization, signs of evaporation, or the formation of solids in the bottle, **do not handle the container** and c**ontact EH&S, ext.75179** immediately. Secure the area and restrict access to the container until it can be evaluated by EH&S personnel.

d. 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 prior to disposal. Many pyrophoric and reactive compounds can be stabilized using a quenching procedure prior to disposal. Chemicals classified by the Department of Transportation (DOT) as explosives (e.g., many nitro- and azo-compounds) will require special packaging and shipping, and may require stabilization prior to disposal. Consult with the Chemical Hygiene Officer and the Hazardous Waste Manager for disposal considerations of these compounds.

8. Managing Empty Containers

Empty containers do not have to be managed as hazardous waste. To be considered empty:

- No material can be poured or scraped from a container.
- An aerosol container must have its contents and pressure completely dispensed, and the spray mechanism in place and functional.

Notes and Exceptions:

- All containers that once held acutely / extremely hazardous materials are considered hazardous waste and must be disposed of by EH&S.
- If an empty hazardous material container is greater than five gallons, it must be picked up by EH&S.

9. 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 instructional and/or research wastes. Special pick-ups and laboratory clean-outs are available upon request. For information regarding waste disposal, please contact the Hazardous Waste Manager, located in the EH&S Department.

10. Disposal

Request a pickup via the internet:

- Visit www.csusb.edu/forms
- Fill out the "Chemical Waste Collection" form.
- EH&S will pick up your waste within 1-3 days.

Do not dispose of chemicals by pouring them down the drain or placing them in the trash. Do not use fume hoods to evaporate chemicals.

D. Hazardous Waste Minimization

In order to reduce the amount of chemicals that become waste, administrative and operational waste minimization controls can be implemented. Usage of chemicals in the laboratory areas should be reviewed to identify practices which can be modified to reduce the amount of hazardous waste generated.

Purchasing Control: 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. Please do not overstock chemicals just for a better deal, consider the storage space and practical amount to be used throughout the experimental process.

Inventory Control: Rotate chemical stock to keep chemicals from becoming outdated. Locate surplus/unused chemicals and attempt to redistribute these to other users.

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

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

E. Mercury Thermometer Exchange Program

Cleaning up spilled mercury from a broken thermometer is the most frequent EH&S HazMat response. Mercury is a potent neurotoxin and environmental contaminant, and CSUSB has a goal of having a mercury free campus. EH&S will exchange mercury thermometers with non-mercury thermometers free of charge.

X. Accidents, Emergencies, and Chemical Spills

A. 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 procedures 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 CSUSB Emergency Procedures flip chart provides an overview of emergency response procedures. It should be posted in each laboratory.

For all incidents requiring emergency response, call CSUSB Campus Police Department at 911 from a campus phone.

B. 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 **supervisor and EH&S, ext. 75179**. An injury, incident, or safety concern can also be reported to EH&S. EH&S will conduct an accident investigation and develop recommendations and corrective actions to prevent future accidents. At a minimum, each laboratory must have the following preparations in place:

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

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);	• 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

• Always label and store chemicals properly; • Always keep the work area clean and uncluttered	• Never use damaged glassware or other equipment

If an employee has a **severe or life threatening injury, call for emergency response at 911** from a campus phone or from an off-campus phone. Employees with minor injuries should be treated with first aid kits as appropriate, and sent to **Healthpointe** at 290 N 10th St #100, Colton, CA 92324, (**909-264-2500**) for evaluation and treatment. After normal business hours, treatment can be obtained at designated medical centers and emergency rooms.

Serious occupational injuries, illnesses, and exposures to hazardous substances must be reported to the supervisor and EH&S, ext. 75179 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. EH&S must ensure that all serious injuries are reported to Cal/OHSA within 8 hours.

C. 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 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 can be used if available). Report to your supervisor and EH&S, ext. 75179 within 8 hours every time a fire extinguisher is discharged.

D. Chemical Spills

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

- The spill results in a release to the environment (e.g., sink or floor drain);
- The material or its hazards are unknown;
- Laboratory staff cannot safely manage the hazard because the material is too hazardous or the quantity is too large (over 1 liter).

Table 10.2 gives some factors to consider before cleaning a spill.

Table 10.2 – Factors to Consider Before Spill Clean-up

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

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 CSUSB chemical exposure procedures as appropriate (see *Section V: 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, follow the instructions on 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.

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

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

- Evacuate all non-essential persons from the spill area;
- If needed, call for medical assistance by dialing **911** from a campus phone or from an off-campus or cell phone;
- Make sure you are wearing/using SDS recommended PPE before assisting other people and/or cleaning up;
- Help anyone who may have been contaminated. Use emergency eyewashes/showers to flush the skin or eyes for *at least 15 minutes*;

- Post someone just outside the spill area to keep people from entering. Avoid walking through contaminated areas;
- You must have the proper protective equipment and clean-up materials to clean-up spills. Check the chemical's Safety Data Sheet (SDS) in your laboratory or online for spill clean-up procedures, or call EH&S for advice;
- Turn off sources of flames, electrical heaters, and other electrical apparatus, and close valves on gas cylinders if the chemical is flammable (stop ongoing processes if necessary);
- Confine the spill to a small area. Do not let it spread;
- Avoid breathing vapors from the spill. If the spill is in a non-ventilated area (confined space), do not attempt to clean it up. Call for emergency personnel to respond and clean up the spill;
- Wear personal protective equipment, including safety goggles, gloves, and a laboratory coat or other protective garment to clean-up the spill (consult with SDS);
- Work with another person to clean-up the spill. Do not clean-up a spill alone
- **DO NOT ADD WATER TO THE SPILL**
- Use an appropriate kit to neutralize and absorb inorganic acids and bases. For other chemicals, use the appropriate kit or absorb the spill with sorbent pads, paper towels, vermiculite, dry sand, or diatomaceous earth. For mercury spills and for all other spills requiring specialized clean-up procedures see Appendix I.

ii. What to do with a Large Chemical Spill (>1 Liter)
Large chemical spills require emergency response. Call 911 from a campus phone or 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.

- Call for emergency response/medical assistance by dialing 911;
- Make sure you are wearing/using SDS recommended PPE before assisting other people and/or cleaning up;
- Remove the injured and/or contaminated person(s) and provide first aid;
- Help anyone who may have been contaminated. Use emergency eyewashes/showers by flushing the skin or eyes for at least 15 minutes;
- Evacuate laboratory. 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 the exhaust ventilation on;
    - If possible, turn off all sources of flames, electrical heaters, and other electrical equipment if the spilled material is flammable (stop ongoing processes if necessary);
    - 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.

Table 10.2 gives examples of highly toxic chemicals that require emergency response for clean-up.

Table 10.3 – 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
- Nitriles
- Nitro-compounds
- Organic halides

APPENDIX A: GENERAL RULES FOR LABORATORY WORK WITH CHEMICALS

PRDENT LABORATORY PRACTICES

It is prudent to minimize all chemical exposures. Few laboratory chemicals are without hazards. General precautions for handling all laboratory chemicals should be adopted, as well as 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

- Wear closed-toe shoes with an enclosed heel and full length pants, or equivalent, at all times when in the laboratory.
- Utilize appropriate PPE while in the laboratory and while performing procedures that involve the use of hazardous chemicals or materials. These items may include but not limited to laboratory coats, gloves, and safety glasses or goggles.
- Confine long hair and loose clothing and accessories.
- 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. Wash hands thoroughly before leaving lab or upon completion of an experiment to further remain any remaining contamination.
- Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken.
- Ensure that appropriate PPE is worn by all persons, including visitors, where chemicals are stored or handled
- Use appropriate respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls. Inspect the respirator before use. Use of respirators requires a respirator hazard assessment, successful completion of the EH&S Respirator Training, and Fit Test course. Review CSUSB's Respiratory Protection Program for more information.
- Use any other protective and emergency apparel and equipment as appropriate. Be aware of the locations of first aid kits, emergency eyewash and shower stations, and other emergency or first aid equipment.

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. Use secondary containment at all times.
- Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan.
- In the case of an accident or spill, refer to the emergency response procedures for the specific material. These procedures should be readily available to all personnel. Information on minor chemical spill mitigation may also be referenced in Appendix I. For general guidance, the following situations should be addressed:

- Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes minimum) and seek medical attention.
- Skin Contact: Promptly flush the affected area with water for at least 15 minutes and remove any contaminated clothing. If symptoms persist after washing, seek medical attention.
- Clean-up: Promptly clean up spills, using appropriate protective apparel and equipment, and proper disposal.

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 at all times, except when adjustments within the hood are being made or when the hood is actively being used by a researcher.
- 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."

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 • If minors are in laboratories be sure to follow CSUSB's Policy on Minors in Labs and Shops.
- Receive both Lab Safety Fundamentals and lab specific training prior to starting work in a lab.

UNSAFE LABORATORY HABITS

Personal Protective Equipment

- 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.
- Do not wear laboratory coats or gloves outside of the laboratory area

Chemical Handling

- Do not smell or taste chemicals.
- Do not allow release of toxic substances or fumes into cold or warm rooms, as these types of areas typically involve re-circulated atmospheres.
- Never use mouth suction for pipeting 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.

Equipment Storage and Handling:

- Do not use damaged glassware or other equipment, under any circumstances. The use of damaged glassware increases the risks of implosion, explosion, spills, and other accidents.
- Do not use uncertified fume hoods or glove boxes for hazardous chemical handling.
- Avoid storing materials in hoods and do not allow them to block vents or air flow.

Laboratory Operations:

- Never work alone on procedures involving hazardous chemicals, biological agents, or other physical hazards.
- Avoid unattended operations, if at all possible. Unattended operations require prior approval from the PI/Laboratory Supervisor.
- Do not engage in distracting behavior such as practical joke playing in the laboratory. This type of conduct may confuse, startle, or distract another worker.

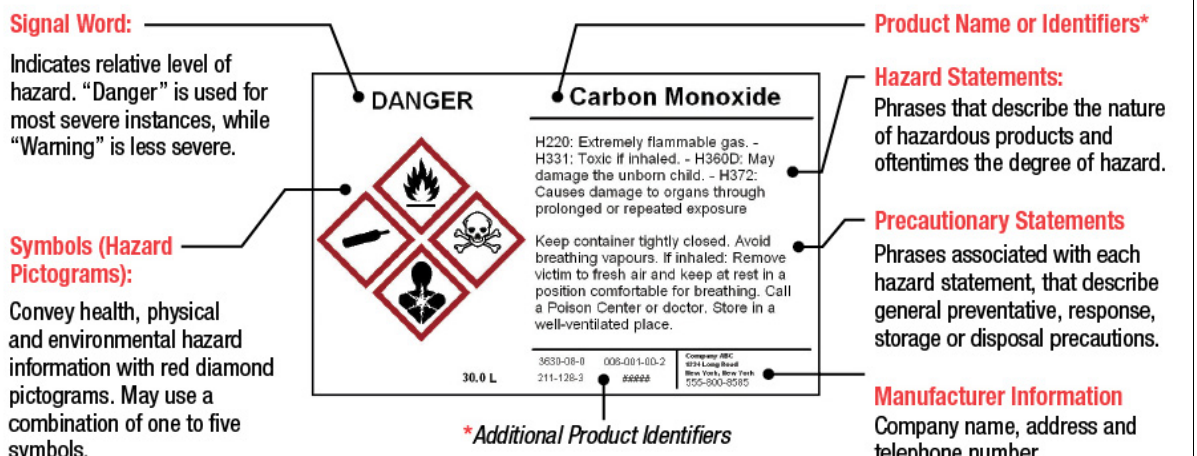
Food/Drink

- Do not eat, drink, smoke, chew gum, or apply cosmetics (including chapstick) in areas where laboratory chemicals are present; wash hands before conducting these activities.
- Do not store, handle, or consume food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations.
- Wash areas of exposed skin well before leaving the laboratory.

APPENDIX B: CONTAINER LABELING

Chemical container labels are a good resource for information on chemical hazards. All containers of hazardous chemicals must have labels attached. Figure B.1 displays the label requirements.

Figure B.1 – GHS Container Labeling Requirements



The warning may be a single word (e.g. Danger, Caution, Warning) or may identify the primary hazards, including both physical (e.g. water reactive, flammable, or explosive) and health (e.g. carcinogen, corrosive or irritant), such as what is found on the hazard warnings from the label or SDS. The label will also have hazard pictograms associated with the degree of hazard.

Most labels provide additional safety information to help workers protect themselves from the substance. This information may include protective measures and/or protective clothing to be used, first aid instructions, storage information and emergency procedures. For further information on the product, please consult the manufacturer's SDS. Table B.2 gives guidelines for laboratory personnel and proper chemical labeling use.

Table B.2 – Chemical Labeling – What are Laboratory Personnel Responsible for?

- Inspecting incoming containers to be sure that labels are attached and are in good condition and contain the information outlined above;
- Reading the container label each time a newly purchased chemical is used. It is possible that the manufacturer may have added new hazard information or reformulated the product since the last purchase;
- Ensuring that chemical container labels are not removed or defaced, except when containers are empty;
- Labeling any secondary containers used in the laboratory, to prevent unknown chemicals or inadvertent reaction;
- Verifying that chemical waste containers have complete and accurate chemical waste labels.

Labeling is important for the safe management of chemicals, preventing accidental misuse, inadvertent mixing of incompatible chemicals, and facilitating proper chemical storage. Proper labeling helps ensure quick response in the event of an accident, such as a chemical spill or

chemical exposure incident. Finally, proper labeling prevents the high costs associated with disposal of “unknown” chemicals. With the exception of transient containers that will contain chemicals for immediate use, all containers of chemicals being used or generated in CSUSB research laboratories must be labeled sufficiently to indicate the contents of the container. On original containers, the label must not be removed or defaced in any way until the container is emptied of its original contents. Incoming containers must be inspected to make sure the label is in good condition. It is also advisable to put a date on new chemicals when they are received in the laboratory, and to put a date on containers of chemicals generated in the laboratory, as well as the initials of the responsible person.

Abbreviations or other acronyms may be used to label containers of chemicals generated in the laboratory as long as all personnel working in the laboratory understand the meaning of the label, or know the location of information, such as a laboratory notebook or log sheet that contains the code associated with content information. In addition, small containers, such as vials and test tubes, can be labeled as a group by labeling the outer container (e.g., rack or box). Alternatively, a placard can be used to label the storage location for small containers (e.g., shelf, refrigerator, etc.). This information must be provided to janitorial and maintenance staff as part of their hazard communication training.

Containers of practically non-toxic and relatively harmless chemicals must also be labeled with content information, **including containers such as squirt bottles containing water**.

With respect to chemical labeling, all potentially chemicals transferred from their original container to a second container must be labeled with a compliant GHS chemical name and the principal hazards found on the primary container label or SDS. For more information on labeling, see *Section VI: Labeling, Storage, Inventory and Transport*.

APPENDIX C: SOP INSTRUCTIONS AND TEMPLATE

Per OSHA, SOPs are Required When Working with Hazardous Chemicals
To determine if an SOP is needed, update your chemical inventory in order to identify the need for Banded SOPs and Chemical Specific SOPs. Lab specific processes that involve hazardous materials and require SOPs should be identified by the PI/Laboratory supervisor and lab personnel.

What is a Standard Operating Procedure?
An SOP is a written document that clearly outlines the steps to be followed when carrying out a given operation or experiment so that a process can be replicated in a safe manner by any person reading it. It provides individuals with information to perform a procedure properly and facilitates consistency in the quality and integrity of the end result.

Procedures and Requirements for Writing SOPs

- **Step 1:** After identifying the needed SOPs, review the CSUSB EH&S SOP Template library for templates of bands, processes, and chemicals or for a blank SOP template to use in order to complete your lab's SOPs. (Note: Labs are not required to use the EH&S SOP templates, but are required to complete SOPs).
- **Step 2:** Using a template from the SOP library or by creating your own, customize it with lab-specific information and procedures/protocols. This has to be done by laboratory personnel with the most experience with the described procedure/protocol and/or chemical and who are routinely involved with the experimental process.
- **Step 3:** Once the SOP is written, it must be reviewed and signed by the PI/Laboratory supervisor and all personnel responsible for performing the procedures detailed by the SOP. Signing the SOP indicates that the signer understands the contents, requirements, and responsibilities. (Note: Personnel not utilizing described chemical or procedure/protocol should not sign the SOP).
- **Step 4:** Maintain a copy of the signed SOP in the Laboratory Safety Binder or separately designated manual that is readily available to all lab personnel to review as required.

SOP requirements at CSUSB
The CSUSB EH&S has created an SOP Template library which will serve as a valuable tool for researchers in order to fulfill a Cal/OSHA requirement for the need of SOPs when working with hazardous chemicals. An SOP is not complete until the lab completes the procedure/protocol section of the document.

Three sub-categories were created in order to help researchers avoid unnecessary work and to make these documents useful in research.

The first category is called "**Banded SOPs**". In order to classify these chemicals the chemical inventory program takes in account specific physical and chemical properties as well as physical and/or health hazards. Several chemicals will fall under more than one bands but the primary band that will be identified by the program will be the important one for each chemical. The primary chemicals from each band that are not in use can be marked as "**Not in use**" or "**For storage only**". A process or procedure/protocol has to be described when chemicals are in use. Clear instructions on banded and chemical specific SOP can be found in Chemical Inventory program at the SOP tab when the PI or laboratory supervisor signs in. Other bands could also be created by individual labs with families of chemicals that are used in a reaction the same way like Grignard reagents, organo-lithium reagents, etc.

The second category is called "**Process SOPs**". PIs and lab personnel have to identify specific hazardous processes performed regularly at their locations and SOPs have to be created for them. The template library has several process SOPs in place but labs will have to customize accordingly. A process could include the use of specific equipment like rotary evaporators, centrifuges, and etc. A process could also include specific known reactions that are regularly performed by lab personnel like Heck reaction, Suzuki reaction, etc.

The third category is the "**Chemical Specific SOPs**". All regulated carcinogens are required by Cal/OSHA to have individual SOPs. Chemicals utilized for animal research and are included in animal protocols are also required to have SOPs. The lab can chose to also maintain individual chemical SOPs for all primary chemicals in the bands.

Steps to follow for identifying lab SOPs needed for lab operations:

- Step 1: Update the lab Chemical Inventory by adding new chemicals when they arrive and removing chemicals that have been completely used and container has been disposed of. On an annual basis EH&S employees will be verifying the validity of the inventory and will be making necessary additions and removals.
- Step 2: Identify the bands and the chemicals that fall under every band.
- Step 3: Identify what chemicals require individual SOPs. In addition to regulated carcinogens, any chemical included in an animal protocol is required to have an SOP.
- Step 4: Identify all Exhibit 1 chemicals and the band they belong to. These chemicals are required to have the procedure/protocol section completed. This applies only to the Settlement labs.
- Step 5: PI/Laboratory Supervisor and/or lab personnel need to identify lab specific processes. These could be specific, known or regularly used reactions or procedures. These could also be certain commonly used equipment.

Proposed Bands

Primary Bands:

Chemicals that fall under these bands pose an immediate hazard to the worker or are regulated and require chemical specific procedures.

1. Regulated Carcinogens;
2. Strong corrosive chemicals;
3. Water reactive chemicals;
4. Air reactive chemicals;
5. Acutely toxic chemicals (LD50 equals or lower than 50mg/kg for rats);
6. Explosive chemicals;
7. Highly Flammable chemicals;
8. Peroxide forming chemicals;
9. Toxic gases.

Secondary Bands:

Chemicals that fall under these bands can have a generic procedure that covers all chemicals under each band. These bands will have two sub categories: Solvents, non-solvents.

1. Carcinogens and reproductive toxicants;
2. Flammable chemicals;
3. Corrosive chemicals;
4. Potentially explosive chemicals and oxidizers;
5. Sensitizers, Irritants and toxic chemicals;

6. Compressed gases;
7. Harmful and lower hazard chemicals;
8. Non-hazardous chemicals.

How to Write an SOP Protocol or Procedure

SOP Protocol or Procedure
Templates from the CSUSB EH&S SOP Template library must be customized, by lab groups using chemicals, to include lab-specific information. In particular, the labs must complete the protocol/procedure section of the SOP detailing the use of chemicals or equipment so that it can be followed safely and consistently. It is important that this section is written by the most experienced and knowledgeable lab personnel for the various uses of the chemicals or equipment and reviewed by the PI/Laboratory Supervisor. SOPs are required in order to work with hazardous chemicals listed as per Cal-OSHA.

Steps for Writing Protocols/Procedures

- Step 1: Give a general range of quantities that can be used in a safe and consistent manner. If necessary provide two procedures to cover a wider range of quantities.
- Step 2: Outline the conditions under which the procedure applies (temperature, pressure).
- Step 3: Provide a step-by-step explanation of a general experimental procedure covered within the range of quantities. Provide details on engineering controls and hazards associated with the procedure.
- Step 4: Include a specific example procedure describing in detail the experiment. This could be an experimental procedure from your lab notebook or from a publication.
- Step 5: If quantities or conditions significantly deviate from the SOP be sure to obtain approval from the PI/Laboratory Supervisor, and include any changes to an updated SOP.

Example:
Protocol / Procedure
Quantities covered by this SOP: 0-40 g
Conditions covered by this SOP: 0°C – 50°C
General: Sodium hydroxide pellets are used to make aqueous solutions that range from 0.01M to 1M and volume of 10 ml to 1 L. The sodium hydroxide pellets are weighed and then slowly added to a beaker of water that is cooled in an ice bath under constant stirring on a stirring plate. Caution: Dissolution of sodium hydroxide is highly exothermic. The solution is stirred until all sodium hydroxide is dissolved. It is then allowed to reach room temperature. The final concentration is determined by titration with potassium hydrogen phthalate.

Example: Preparation of 1L of 1M sodium hydroxide solution.
40g of NaOH pellets was weighed out in a plastic weigh boat. A 2L beaker containing 1L of water and a stirring magnet was placed in an ice bath over a stirring plate. The pellets were added slowly to the water. When all pellets were completely dissolved the beaker was removed from the ice bath and allowed to reach room temperature before solution got titrated with potassium hydrogen phthalate. NOTE: Any deviation from this SOP requires approval from PI.

APPENDIX D: SAFE USE OF PARTICULARLY HAZARDOUS SUBSTANCES

Safe Handling of Particularly Hazardous Substances Guidelines

I. REFERENCES

- 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);

II. PURPOSE

To provide 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.

III. STATEMENT

These guidelines apply to all CSUSB laboratory workers (i.e., Principal Investigators, laboratory supervisors, 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 EH&S, ext. 75179 for guidance on use of chemicals that may require further controls.

IV. LABORATORY SAFETY REQUIREMENTS & PROCEDURES

A. Laboratory Specific Standard Operating Procedures

- 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.

- A copy of the particularly hazardous substances procedures, including laboratory specific information, and the Safety Data Sheets (SDS) for the chemical(s) used must be readily accessible in the lab.

- EH&S must be notified immediately 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 24hours of the event.

- Principal Investigators/Laboratory Supervisors must identify what classes of particularly hazardous substances are in use in their labs and identify the appropriate personal protective equipment (PPE) on their Laboratory Hazard Assessment Tool, 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/Laboratory Supervisor 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 training. Records of laboratory-specific training must be maintained in the laboratory and should include an outline of the topics covered. 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, SDSs for chemicals in use, and the Chemical Hygiene Plan (CHP).
    - A review of these guidelines.

2. All laboratory personnel are responsible for knowing and complying with all safety guidelines, regulations, and procedures required for the task assigned. They are also responsible for reporting unsafe conditions, accidents or near misses to the Principal Investigator/Laboratory Supervisor, 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. Written records must be maintained for each training session.

C. Use in Designated Areas

- 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.

- 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/Laboratory Supervisor, or their designee, to train and authorize their staff for these operations and to maintain documentation of this training and authorization.

- Signage is required for all containers, designated work areas and storage locations. Sign wording must state the following, or similar, 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 EH&S Department upon request.

- Work surfaces should be stainless steel, plastic trays, dry absorbent plastic backed paper, chemically resistant epoxy surfaces, or other chemically impervious material.

- 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/Laboratory Supervisors 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)

- PPE must be sufficient to protect eyes, skin, and lungs 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. 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. Respirators might also be required if engineering controls are not adequate or not available.

- Refer to the specific chemical’s SDS and SOP for specific information on additional PPE and glove selection.

- 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 Chemical Hygiene Plan for guidance on handling contaminated protective apparel and other PPE.

E. Engineering Controls

- 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 EH&S, ext. 75179.

- 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 and Storage Requirements

- 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.

- Chemicals should be segregated from incompatible materials, as described in the CSUSB Chemical Hygiene Plan. The use of particularly hazardous substances must be confined to an established designated area (see Section C. Use in Designated Areas, above).

- Additional requirements for the safe storage of a specific chemical may be found in the manufacturer's instructions or in the SDS.

- When transporting chemicals beyond the immediate laboratory environment, containers should be protected from breakage by using a bottle carrier or other effective containment.

- Contact EH&S, ext. 75179 for guidance on the planned use of chemicals that may require further controls.

G. Spill Accident Procedures

- 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, equipment, and areas. Any known spills must be contained and decontaminated as soon as possible. Any drains in the vicinity of the spill need to be protected.

- 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 immediately for response. Call 911 from an on-campus phone or from a cell phone (to CSUSB PD).

- 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 ext. 75179 and an incident report will be completed and maintained by EH&S.

- 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.

- 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

- 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.

- 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.

- Contaminated PPE must not be removed from the designated area until properly decontaminated. 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

- Disposal of waste materials that include particularly hazardous substances must comply with the hazardous chemical waste disposal procedures found in the Chemical Hygiene Plan.

- 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"

- All non-radioactive chemical waste must be disposed of through the CSUSB Hazardous Waste Management Program. Due to regulatory restrictions and the high cost of disposal, the Radiation Safety Officer should be contacted prior to producing mixed wastes of hazardous chemicals and radioactive material.

J. Related Carcinogens and Report of Use Requirements

- 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 minimize exposure and keep exposure levels below these limits by using fume hoods, limiting the quantities used, and following SOP designed to reduce exposure. If levels of regulated carcinogens 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

- 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 an EH&S approved process. If you have or intend to purchase any of these chemicals first consult with EH&S at ext. 75179. 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.

K. Attachments

- A. Particularly Hazardous Substances Definitions
- B. Regulated Carcinogens
- C. Listed Carcinogens

ATTACHMENT A: Particularly Hazardous Substances Definitions

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

Section 1.01: Acutely Toxicants
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.

Section 1.02: 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 by the Office of Environmental Health Hazard Assessment (OEHA) at https://oehha.ca.gov/media/downloads/proposition-65//p65list112318.pdf.

Section 1.03 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:

- It is regulated by Cal/OSHA as a carcinogen; or
- It is listed under the category “known to be carcinogens” in the annual report by the National Toxicology Program (NTP); or
- It is listed under Group 1 – “carcinogenic to humans” – by the International Agency for Research on Cancer (IARC); or

- 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.

- 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

ATTACHEMENT 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.

- 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 E: RESPIRATORY HAZARD ASSESSMENT FORM

To be completed by CSUSB employee

CSUSB EH&S RESPIRATORY HAZARD EVALUATION (Part 1)

Job Title:			**Date:**
Department:			
Supervisor Name:		**Phone Extension:**	**Email:**
Employees Represented by Evaluation:			
Name	*CSUSB Coyote ID*	*Name*	*CSUSB Coyote ID*

Process Description:		
Identity of Contaminant(s)/ Hazards?	**Quantity of contaminant(s) used per unit time:**	**Duration of Exposure:**
Controls and/or personal protective equipment being used to minimize or eliminate exposure?		
Expected physical work effort: □ High □ Moderate □ Low		

Physical Work Effort Key

- ***High:*** *Examples of activities are sawing by hand, shoveling dry/wet sand, intermittent heavy lifting with pushing or pulling*
- ***Moderate:*** *Examples of activities are scrubbing in standing position, walking about with moderate lifting or pushing*
- ***Low:*** *Examples of activities are sitting with moderate arm and leg movements, standing with light work at machine or bench while using mostly arms or with some walking about*

(Part 2: To be completed by EH&S)
CSUSB EH&S RESPIRATORY HAZARD EVALUATION (Part 2)

Evaluation By:	**Reviewed By:**		□ **New**	□ **Revised**
What type of respiratory hazard is present?	□ Oxygen Deficiency □ Combination	□ Gas/Vapor □ Biohazard	□ Particulate/ Aerosol	*Rev. Date*

Respiratory Hazard(s)	TLV[1]	STEL/PEL[1]?	Concentration in the atmosphere[2]?

1 Mark "NONE" if value is not available
2 Provide reasonable estimate if sampling data is not available

Relative Humidity: (*report potential range)*	Temperature: (*report potential range*)

Are IDLH conditions possible?	□ No □ Yes	Is hazard an eye irritant?	□ No □ Yes
Are engineering controls available?	□ No □ Yes	Is hazard absorbed through the skin?	□ No □ Yes

Is a respirator required?	□ No □ Yes (*Based on exposure/potential/protocol)* □ Voluntary Use Only *Article II. Provide Appendix D*	Check all that apply: □ Half-face □ SCBA □ PAPR	*(Refer to Appendix B (Respiratory Protection Program-Respirator Decision Logic Sequence)* □ Full face □ Air line □Filtering Facepiece

Cartridge type(s) to be issued and approximate weight of respirator + cartridge(s): *(Refer to Appendix B (Respiratory Protection Program-Respirator Decision Logic Sequence)*

Recommended Change Schedule for Cartridges: *(NOTE: for formaldehyde, change cartridges every 3 hours)*

Additional required and/or recommended personal protective equipment (PPE):

Expected duration and frequency of respirator use:

CSUSB EH&S RESPIRATORY PROTECTION VOLUNTARY USE AFFIDAVIT

Date _____

Department _____

Location _____

Process/Procedure:

Respirator Information (brand, type, etc.): _____

I/We understand that a respiratory hazard evaluation was performed to determine the need for respiratory protection while performing the above mentioned process/procedure.

I/We acknowledge that the results of the evaluation indicate that respirator use is not required while performing the above mentioned process/procedure and that any respirator use during the process/procedure is strictly **voluntary**.

In addition, I/we further acknowledge that I/we received training on the proper use and limitation of the respirator and received a copy of Appendix D “Information for Employees Using Respirators When Not Required under the Standard” pursuant to all applicable Respiratory Protection standards.

Print Name	Signature

APPENDIX F: PEROXIDE FORMING CHEMICALS COMMON TO RESEARCH

Class 1 PFCs
Class 1 chemicals form peroxides after prolonged storage. The chemicals listed below should be tested for the formation of peroxides on a periodic basis. Several methods are available to check for peroxides; the two most common are the use of peroxide test strips or the potassium iodide test.

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

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 within12 months of receiving.

Examples of Class 2 PFCs
- Acetal
- Cumene
- Cyclohexane
- Cyclopentane
- Diacetylene
- Dicylcopentadiene
- Diethyleter
- Diozane
- Ethylene glycol dimethyl ether
- Furan
- Methylacetylene
- Methcyclopentane
- Methyl isobutyl ketone
- Tetrahydrofuran
- Tetrahydronapthalene
- Vinyl ethers

Class 3 PFCs
This group of chemicals forms peroxides due to initiation of polymerization. When stored in a liquid state, the peroxide forming potential dramatically increases. These chemicals should be disposed of if they become degraded or are no longer needed.

Examples of Class 3 PFCs
- Acrylic acid
- Acrylonitrile
- Butadiene

- Chlorobutadiene
- Chlrortrifluoroethylene
- Methyl methacrylate
- Styrene
- Tetrafluoroethylene
- Vinyl acetate
- Vinyl acetylene
- Vinyl chloride
- Vinyl pyridine
- Vinylidene chloride

APPENDIX G: SAFE USE OF PYROPHORIC REAGENTS

Procedures for Safe Use of Pyrophoric Reagents

I. Introduction

In December 2008, a laboratory accident at UCLA occurred while the researcher was working with t-butyl lithium, a highly pyrophoric agent. Pyrophoric materials ignite spontaneously on contact with air; these chemicals react with oxygen, moisture in the air, or both. Failure to follow proper handling procedures can result in fire or explosion, leading to serious injuries/death or significant damage to facilities.

Below are some procedures describing the hazards, proper handling, disposal and emergency procedures when working with pyrophoric materials.

II. Examples of Pyrophoric Materials

- Grignard Reagents: RMgX (R=alkyl, X=halogen)l
- Metal alkyls and aryls: Alkyl lithium compounds; tert-butyl lithium;
- Metal carbonyls: Lithium carbonyl, nickel tetracarbonyl;
- Metal powders (finely divided): Cobalt, iron, zinc, zirconium;
- Metal hydrides: Sodium hydride Nonmetal hydrides: Diethylarsine, diethylphosphine;
- Non-metal alkyls: R_3B, R_3P, R_3As; tetramethyl silane, tributyl phosphine;
- Phosphorus;
- Potassium;
- Sodium;
- Gases: Silane, dichlorosilane, diborane, phosphine, arsine

A more extensive list of pyrophoric compounds can be found in *Bretherick's Handbook of Reactive Chemical Hazards*.

III. Hazards

Pyrophorics must be handled under inert atmospheres and in such a way that rigorously excludes air/moisture since they ignite on contact with air and/or water. They all tend to be toxic and many come dissolved in a flammable solvent. Other common hazards include corrosivity, teratogenicity, water reactivity, and peroxide formation, along with damage to the liver, kidneys, and central nervous system. Be especially vigilant when working with tertiary butyl lithium which is **extremely pyrophoric**. Researchers working with pyrophoric materials must be proficient and must not work alone!

IV. Controlling the Hazards

BEFORE working with pyrophoric reagents, users must:

1. Consult with your PI and confirm that approval has been received when working with highly hazardous materials.
2. Read the relevant Safety Data Sheets (SDS), technical bulletins, and guidance documents to understand and know how to mitigate the hazards. The SDS must be reviewed before using an unfamiliar chemical and periodically as a reminder.
3. Prepare a written Standard Operating Procedure (SOP) identifying the safety precautions specific to the operations.
    - Consider performing a “dry run” to identify and resolve possible hazards before conducting the actual procedure.

- Users of pyrophoric materials must be trained in proper lab technique and be able to demonstrate proficiency.
- Use less toxic or less hazardous substances in your experiment and minimize the amount of hazardous waste generated.

4. Perform a hazard analysis and identify the failure modes in your experiment. Be prepared to handle accidents.
5. Know the location of eyewash/ shower, fire extinguishers, fire alarm pulls, and emergency exits.
6. Complete required EH&S safety training requirements and lab specific training.
7. Use the buddy system. Do not work alone or off hours where there are few people around to help
8. Wear the appropriate personal protective equipment.
    - Use a fire resistant lab coat, goggles/face shield and gloves or other additional PPE as suggested by the SDS.
9. Maintain good work practices.
    - Keep combustible materials, including paper towels and Kimwipes, away from pyrophoric reagents.
    - Minimize the quantity of pyrophoric reagents used and stored and use the smallest quantity of material practical. It is better to do multiple transfers of small volumes than attempt to handle larger quantities. Consider using the cannula method when transferring more than 20 ml.
    - Remove all excess and nonessential chemicals and equipment from the fume hood or glove box where pyrophoric chemicals will be used to minimize the risk of fire.
    - Designate a fume hood or glove box for hazardous work.

A. Personal Protective Equipment (PPE)

Eye Protection

- Chemical splash goggles or safety glasses that meet the ANSI Z.87.1 1989 standard must be worn whenever handling pyrophoric chemicals. Ordinary prescription eye glasses will NOT provide adequate protection unless they also meet this standard. When there is the potential for splashes, goggles must be worn, and when appropriate, a face shield added.
- A face shield, worn over safety eyewear, is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of pyrophoric chemicals which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, clamped to the counter top, may be used if fume hood space is not available.

Skin Protection

- Gloves must be worn when handling pyrophoric chemicals. Nomex pilot gloves should be used for handling these chemicals. Be sure to use adequate protection to prevent skin exposures. Sigma-Aldrich recommends the use of nitrile gloves underneath neoprene gloves.
- A lab coat made from Nomex is required for labs using these reagents. Lab coats need to be buttoned and fit properly to cover as much skin as possible.
- Appropriate shoes, that cover the entire foot (closed toe, closed heel, no holes in the top) must be worn.

B. Safety Equipment

Have the proper equipment and the emergency phone number (9-1-1) readily available for any emergencies.

DO NOT use a carbon dioxide fire extinguisher or water to attempt to extinguish a pyrophoric solid fire as these types of extinguishers can actually enhance the combustion of these pyrophoric materials. A small beaker of dry sand or soda ash (lime) in the work area is useful to extinguish any small fire that occurs at the syringe tip and to receive any last drops of reagent from the syringe.

Eyewash/ Safety Shower

- A combination eyewash/safety shower should be within 10 seconds travel time where pyrophoric chemicals are used. Inside the laboratory is optimum. Bottle type eyewash stations are not acceptable.

Fume Hood

- Verify that your fume hood has been checked in the last 12 months. Many pyrophoric chemicals release noxious or flammable gases, and some pyrophoric materials are stored under kerosene. These materials must be handled in a laboratory hood.

Glove (dry) box

- Glove boxes are an excellent device to control pyrophoric chemicals when inert or dry atmospheres are required.

Gas cabinets

- Storage of pyrophoric gases is described in the California Fire Code, Chapter 41. Gas cabinets, with appropriate 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. All pyrophoric gases must have Restricted Flow Orifices (RFO) installed on the cylinder. Contact your gas supplier for assistance.
- Emergency back-up power should be provided for all electrical controls, alarms, and safeguards associated with the pyrophoric gas storage and process systems.

V. Storage and Disposal

Storage

- Use and store minimal amounts of pyrophoric chemicals.
- Do not store pyrophoric chemicals with flammable materials or in a flammable liquids storage cabinet. Containers carrying pyrophoric materials must be clearly labeled with the correct chemical name, in English, and hazard warning.
- Store as recommended in the SDS. A nitrogen-filled desiccator or glove box, are suitable storage locations.
- If pyrophoric reagents are received in 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 the material is stored.
- NEVER return excess chemical to the original container. Small amounts of impurities introduced into the container may cause a fire or explosion.

- For storage of excess chemical, prepare a storage vessel in the following manner:
    - Select a septum that fits snugly into the neck of the vessel;
    - Dry any new empty containers thoroughly o Insert septum into neck in a way that prevents atmosphere from entering the clean dry (or reagent filled) flask.
    - Insert a needle to vent the flask and quickly inject inert gas through a second needle to maintain a blanket of dry inert gas above the reactive reagent.
    - Once the vessel is fully purged with inert gas, remove the vent needle then the gas line.
        - For long-term storage, the septum should be secured with a copper wire (figure 1A).
        - For extra protection a second same-sized septa (sans holes) can be placed over the first (figure 1B).
        - Use parafilm around the outer septa and (obviously) remove the parafilm and outer septum before accessing the reagent through the primary septum.

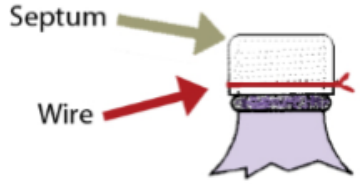


Fig. 1A Septum wired to vessel

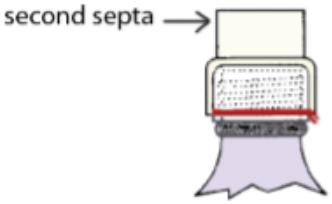


Fig. 1B For long-term storage, use a second septum

Disposal of Pyrophoric Reagents

- A container with any residue of pyrophoric materials should never be left open to the atmosphere.
- Any unused or unwanted pyrophoric materials must be destroyed by transferring the materials to an appropriate reaction flask for hydrolysis and/or neutralization with adequate cooling.
- The essentially empty container should be disposed of as hazardous waste.

Disposal of Pyrophoric Contaminated Materials

- All materials that are contaminated with pyrophoric chemicals should be disposed as hazardous waste. Proper and complete hazardous waste labeling of containers is vital.
- Alert EH&S for any wastes contaminated with pyrophoric chemicals.
- The contaminated waste should not be left overnight in the open laboratory but must be properly contained to prevent fires.

Important Steps to Follow

Pyrophoric reagents can be handled and stored safely as long as all exposure to atmospheric oxygen and moisture is avoided. Finely divided solids must be transferred under an inert atmosphere in a glove box. Liquids may be safely transferred without the use of a glove box by employing techniques and equipment discussed in the Aldrich Technical Information Bulletin AL-134. Pyrophoric gases should be handled in compliance with the California Fire Code, Chapter 41.

Handling Pyrophoric Liquids

- Users should read and understand the Aldrich Technical Information Bulletin No. AL-134. The PI/Laboratory supervisor should also have in place laboratory-specific handling, storage, and disposal standard operating procedures. The standard operating procedures should be included

- By using proper syringe techniques, these reagents can be handled safely in the laboratory. The Aldrich Sure/Seal™ Packaging System provides a convenient method for storing and dispensing air-sensitive reagents.

- The reagent can be dispensed using a syringe or double-tipped needle (16, 18 or 20 gauge) inserted through the hole in the metal cap, as shown in Fig. 2. It is recommended that the plastic cap be replaced after each use and in particular for long-term storage.

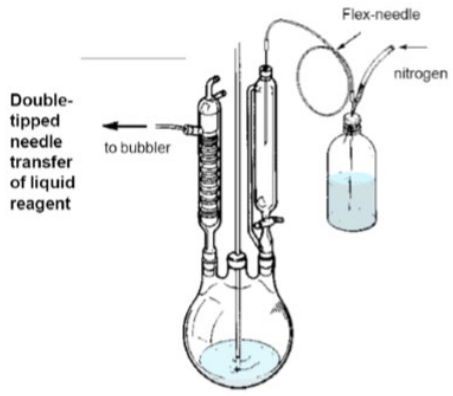


Fig. 2 Double-tipped needle transfer of liquid reagent

- For extended storage of unused reagents, use the solid plastic cap, or equip the bottle with an Oxford Sure/Seal valve cap, or transfer the reagent to a suitable storage vessel, as described above.

VI. Emergency Procedures

Spill

- Powdered lime should be used to completely smother and cover any spill that occurs.
- DO NOT use water to attempt to extinguish a pyrophoric material fire as it can actually enhance the combustion of some pyrophoric materials, e.g. metal compounds.
- Do not use combustible materials (paper towels) to clean up a spill, as these may increase the risk of igniting the pyrophoric compound. Soda ash (powdered lime) or dry sand should be used to completely smother and cover any small spill that occurs.
- A container of powdered lime should be kept within arm's length when working with a pyrophoric material.
- If anyone is exposed, or on fire, wash body with copious amounts of water.
- The recommended fire extinguisher is a standard dry powder (ABC) type. Class D extinguishers are recommended for combustible solid metal fires (e.g., sodium, LAH), but not for organolithium reagents.
- Call 9-1-1 for emergency assistance.

APPENDIX H: SEGREGATION OF INCOMPATIBLE CHEMICALS

Table H.1 contains a list of incompatible chemicals. The following 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.

Table H.1–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.
Sulfides, inorganic	Acids Sulfuric acid Potassium chlorate, potassium perchlorate and potassium permanganate.

Special Segregation of Incompatible Chemicals

In addition to the segregation noted in Table H.1, 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 H.2 contains examples of dangerously incompatible substances. Table H.3 contains examples of incompatible oxidizing agents and reducing agents.

Table H.2–Dangerously Incompatible

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 H.3–Incompatible Oxidizing and Reducing Agents

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

APPENDIX I: SPILL CLEAN-UP PROCEDURES

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, and mercury spills from broken thermometers (about 1.5 grams). If respiratory protection is needed for spill clean-up, the spill is too large to be handled by laboratory personnel – **dial 911 or EH&S, ext. 75179**. Commercial chemical and mercury 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).

Mercury Spills:

- Disposable gloves;
- Disposable shoe covers (plastic bags will work);
- Index card or rubber squeegee;
- Disposable syringe or a vacuum trap flask fitted with tubing or Pasteur pipette;
- Inactivating solutions and/or powders;

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;
        - Soda ash;
        - Sodium bisulfate;
        - Citric acid.
3. Absorb the neutralized liquid with an **Absorbent** such as:
    - Sorbent pads;
    - Diatomaceous earth;
    - Dry sand;
    - Sponges;
    - Paper towels;
    - Vermiculite.

Rinse the absorbent pads or sponges in a sink with water if chemicals involved do not include any other high hazard substances like acutely toxicants or carcinogens. Scoop or place the

other absorbent materials into a clear plastic bag. Double bag and tag the bag with a chemical waste label. Fill out the “Hazardous Waste Collection” form to request a pickup via the internet.

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.

Broken Mercury Thermometer Clean Up Procedure

1. Clean up the spill immediately after it has occurred.
2. Prevent the spread of the spilled mercury. Do not allow people to walk through spill area.
3. Wear disposable gloves and shoe covers or place plastic bags over your shoes during the cleanup.
4. Push the mercury droplets together into a bead using an index card or rubber squeegee.
5. Aspirate the beaded mercury into a disposable syringe, or use a disposable Pasteur Pipette attached with tubing to a vacuum flask to aspirate the mercury into the flask. The flask should contain water. Always have a second vacuum flask between the mercury flask and the house vacuum.
6. Chemically inactivate any residual mercury. There are several methods to inactivate the residual mercury including:
    - Use a commercial inactivating powder following its directions for use
    - Sprinkle zinc powder over the spill area. Then moisten the zinc with a 5 to 10 percent sulfuric acid solution until a paste is formed. Scour the contaminated surface and allow the paste to dry. Sweep up the dried paste.
    - Wash the contaminated area with a detergent solution. Rinse and then swab the area with a calcium polysulfide solution containing two to four tablespoons of calcium polysulfide per gallon of water.

Place the collected mercury and materials used in the clean-up into a clear plastic bag. Double bag and label the waste. Fill out the “Hazardous Waste Collection” form to request a pickup.

If a large spill occurs, call 911 from a campus phone or from an off-campus or cell phone or EH&S, ext. 75179.

APPENDIX J: 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-32372.

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

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

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

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

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

1. Flammable aerosol - an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;
2. Flammable gas - a gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13% by volume or less; or a gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12% by volume, regardless of the lower limit. (GHS definition: A gas having a flammable range with air at 20°C and a standard pressure of 101.3kPa;
3. Flammable liquid - any liquid having a flashpoint below 200°F (93°C; 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)

GHS LABEL - Any written, printed or graphic material displayed on or affixed to containers of chemicals, both hazardous and non-hazardous containing signal word, description, and pictograms for better clarification of the type of chemical.

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

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

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

HAZARDOUS MATERIAL (DOT) - A substance or material capable of posing an unreasonable risk to health, safety, and property when transported including, but not limited to, compressed gas, combustible liquid, corrosive material, cryogenic liquid, flammable solid, irritating material, material poisonous by inhalation, magnetic material, organic peroxide, oxidizer, poisonous material, pyrophoric liquid, radioactive material, spontaneously combustible material, 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, and neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes or mucous membranes. A chemical is also considered hazardous if it is listed in any of the following:

1. OSHA, 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances;
2. “Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment,” ACGIH (latest edition);
3. “The Registry of Toxic Effects of Chemical Substances,” NIOSH (latest edition); 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 (LD50) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each;
2. A substance that has a median lethal dose (LD50) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each; or

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

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

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

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

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.

SAFETY DATA SHEET (SDS) - Written or printed material concerning a hazardous chemical which is prepared in accordance with paragraph (g) of 29 CFR 1910.1200. Formerly known as a Material Safety Data Sheet (MSDS).

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

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

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

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

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

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

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

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

PERSONAL PROTECTIVE EQUIPMENT - Any devices or clothing worn by the worker to protect against hazards in the work 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 will spontaneously ignite in the air at a temperature of 130°F (54.4°C) or below.

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

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

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

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