Chemical Hygiene Plan

San José State University

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Facilities Development and Operations Department

Environmental Health and Safety

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I. INTRODUCTION

A. PURPOSE

San Jose State University (SJSU) is home to a rich culture of scientific exploration and innovation aimed at pushing the bounds of scientific knowledge in teaching and research laboratories. As part of our mission to train the next generation of scientists, we take pride in providing our students, researchers, and staff with the tools needed for a lifetime of success, which includes a solid foundation in how to innovate and experiment safely.

The purpose of the SJSU Chemical Hygiene Plan is to provide guidance and expectations for safely using and managing hazardous chemicals within research and teaching laboratories at SJSU. The Chemical Hygiene Plan provides direction on the types of procedures, equipment, work practices, and personal protective equipment that, combined, protect our laboratory personnel from the potential health and physical hazards inherent to working with hazardous chemicals.

B. SCOPE

The SJSU Chemical Hygiene Plan applies to all laboratory personnel who handle or may be exposed to hazardous chemicals in laboratories on the SJSU campus. A laboratory, as defined by California's Occupational Safety and Health Administration (Cal/OSHA, 8 CCR § 5191), is a workplace where hazardous chemicals are used or stored in relatively small quantities for research. This includes teaching and research laboratories that use small quantities of commercially available ("off the shelf") hazardous chemicals as part of their research.

The SJSU Chemical Hygiene Plan does not apply to those using commercially available products containing chemical hazards as those products were intended in a standard, non-experimental process (e.g. cleaning products used by custodial services, commercial paints used by the paint shop). Use of chemicals by these individuals is covered by SJSU's Hazard Communication Program and is governed by Cal/OSHA's Hazard Communication Standard (8 CCR §5194). The Chemical Hygiene Plan also does not apply to students enrolled in laboratory courses occurring in teaching labs where hazardous chemicals are used or stored, as course-specific lab safety is covered by course safety protocols as required and provided by the instructing faculty member.

II. ROLES AND RESPONSIBILITIES

A. UNIVERSITY LEADERSHIP: PRESIDENT, PROVOST, AND VICE PRESIDENTS

- Provides institutional leadership to promote a culture of safety at San José State University.
- Has the ultimate responsibility to ensure compliance with the Chemical Hygiene Plan. The President has delegated this authority via Executive Order 1039 to Environmental Health & Safety (EH&S) and the campus Chemical Hygiene Officer to maintain and enforce compliance with the Chemical Hygiene Plan.

B. CHEMICAL HYGIENE OFFICER AND EH&S

The Chemical Hygiene Officer works with and is part of Environmental Health & Safety (EH&S). According to the California Occupational Safety and Health Administration (Cal/OSHA), the Chemical Hygiene Officer provides technical guidance in the development and implementation of policies, procedures, and work practices designed to protect employees from the health and physical hazards in their workspace. To this end, the Chemical Hygiene Officer:

- Establishes, administers, and oversees the implementation of the Chemical Hygiene Plan.
- Works with Colleges, Departments, Principal Investigators, and Laboratory Personnel to develop and implement chemical hygiene policies, standard operating procedures, and safe working practices.
- Provides consultation to Principal Investigators on laboratory hazard assessments and in the development of their laboratory-specific standard operating procedures, upon request.
- Assists Principal Investigators and Laboratory Personnel with the selection of safety controls, including engineering controls, laboratory and workplace standard practices, training, and personal protective equipment to minimize the exposure of researchers to hazardous chemicals.
- Provides technical guidance and investigation for accidents, incidents, and injuries involving chemicals in a laboratory or in a research capacity.
- Works with College Safety Committees, Departments, Principal Investigators, and Laboratory Personnel to continually improve the Chemical Hygiene Plan and chemical safety program. The Chemical Hygiene Plan will be reviewed annually and updated as needed.
- In the absence of the Chemical Hygiene Officer, the Director of Environmental Health & Safety (EH&S) may perform these duties as acting Chemical Hygiene Officer.

C. COLLEGE DEANS AND ASSOCIATE DEANS

- Supports the development and continuous improvement of the safety culture within the departments under their jurisdiction.
- Establishes and maintains programs that provide a safe and healthy work environment, such as College Safety Committees and a laboratory inspection program.
- Assigns a College Safety Coordinator(s) and/or College Safety Team to ensure safety programs and policies are implemented in the College.
- Provides the College Safety Coordinator(s) and/or College Safety Team with the staff and resources necessary to ensure safe laboratory environments in the College.
- Ensures compliance with all safety-related policies and aids in the enforcement of such policies.

D. DEPARTMENT CHAIRS

- Provides the resources necessary to mitigate risk from potential hazards within research and teaching laboratories.

- Provides the Chemical Hygiene Officer with the support and resources necessary to implement and maintain the Chemical Hygiene Plan within their department.
- Works with Principal Investigators in their department found in violation of the Chemical Hygiene Plan or other health and safety policy to ensure corrective action in a timely manner.
- Ensures that training requirements are met.
- Maintains an up-to-date list of staff-member Lab Personnel in their department.
- Discusses and documents contingency plans for any planned leave of absence with Principal Investigators in the department if the Principal Investigator's lab is to remain active during the Principal Investigator's absence.
- Reviews incident/accident reports and works with the Principal Investigator, Lab Personnel, and EH&S to ensure appropriate changes to standard operating procedures are made to prevent future incidents. Disseminates lessons learned appropriately to increase hazard awareness on the SJSU campus.

E. PRINCIPAL INVESTIGATORS

A Principal Investigator is the faculty member responsible for research in their assigned laboratory(s) or assigned as the director of a specific laboratory space. Principal Investigators are responsible for the health and safety of all personnel who handle hazardous chemicals in his or her workplace. The Principal Investigator may delegate safety duties, but they remain responsible for ensuring all health and safety requirements are met.

- Follows the guidelines of the Chemical Hygiene Plan and ensures compliance with all applicable EH&S policies and programs in their lab.
- Identifying the hazards in the laboratory, determining safe procedures and controls, and implementing and enforcing standard safety practices. This requires performing a Laboratory Hazard Assessment and recertifying the Assessment annually and updating it when a new type of hazard is introduced in the lab space.
- Completes a Laboratory Safety Fundamentals course at least every three years.
- Ensures all Laboratory Personnel for which the Principal Investigator is responsible have received adequate safety training.
- Provides training to Laboratory Personnel that addresses the hazards, safety controls, work practices, personal protective equipment, and emergency procedures specific to the laboratory. The PI maintains documentation of this training for all Lab Personnel, including the contents of the training and a list of personnel receiving the training.
- Provides and maintains all personal protective equipment (e.g. lab coats, safety eyewear, gloves, etc.) required for research activities in their laboratory.
- Develops laboratory-specific standard operating procedures (SOPs) and trains Laboratory Personnel on all SOPs relating to their research functions.
- Consults with the campus Chemical Hygiene Officer on the use of higher risk materials or higher risk experimental procedures prior to commencing such activities so that appropriate safety precautions may be implemented.
- Maintains an accurate, up-to-date chemical inventory for their laboratory spaces.

- Ensures that Lab Personnel know where to access Safety Data Sheets for chemicals in the laboratory and ensures that Lab Personnel know how to use these documents.
- Ensures that Lab Personnel properly collect, label, and manage wastes.
- Ensures that labs remain in a clean, orderly, and sanitary condition.
- Ensures safe operation of laboratory equipment through proper installation, routine inspection, repair, and maintenance.
- Monitors the safety performance of Laboratory Personnel and takes action to correct deficient work practices that could lead to injury or illness. These actions shall be documented.
- Minimizes or eliminates actual or potential hazards that could lead to accidents, injuries, or property damage.
- Reports all lab-related emergencies to SJSU Police Department and any injuries to University Personnel for employees or to Risk Management for students. Serious injuries (i.e. death, in-patient hospitalization, amputation, loss of an eye) **must** be reported to EH&S (408-924-1969) by the Principal Investigator immediately in order to comply with Cal/OSHA reporting requirements. Near miss incidents—those that did not result in injury or property damage, but could have given a slight change in circumstances—should be documented and reported to EH&S.
- Discusses and documents contingency plans for any planned leave of absence of the Principal Investigator with the Department Chair if the Principal Investigator's lab is to remain active during the absence.
- Contacts Facilities (408-924-1990) or EH&S to initiate repairs when safety showers, eyewash stations, fume hoods, or other safety-related equipment is not functioning properly.

F. LABORATORY PERSONNEL

All individuals engaged in research laboratories that use, handle, or store potentially hazardous chemicals are considered Laboratory Personnel, and are responsible for:

- Reviewing and following the policies, procedures, and work practices described in the Chemical Hygiene plan and all lab-specific procedures.
- Attending a Laboratory Safety Fundamentals course (online or in person) prior to working in the laboratory and completing a re-training course every three years.
- Using engineering, administrative, or work practice controls to minimize exposure to the hazards in the laboratory environment.
- Wears appropriate personal protective equipment as specified in the Laboratory Hazard Assessment, Safety Data Sheet(s), Standard Operating Procedure, or other applicable documentation.
- Receiving approval from the Principal Investigator prior to working with hazardous chemicals or before modifying existing, reviewed procedures (e.g. scaling up a reaction).
- Properly collecting, handling, labelling, storing, and managing hazardous chemicals and hazardous wastes.
- Ensuring that labs remain in a clean, orderly, and sanitary condition.

- Reporting unsafe conditions, accidents, incidents, and near misses to the Principal Investigator and EH&S.
- Adhering to all University, Department, and laboratory-specific safety policies, procedures, and requirements.

III. TRAINING REQUIREMENTS

A. LABORATORY SAFETY FUNDAMENTALS

Individuals who work with hazardous chemicals in a research laboratory environment, such as Principal Investigators and Laboratory Personnel, must take a laboratory safety fundamentals course before working in the research laboratory. This course may be taken online (e.g. through CSULearn) or in-person. Refresher training is required every three years.

B. COURSE-SPECIFIC (LABORATORY) TRAINING

For teaching courses (e.g. general or organic chemistry lab), the specific hazards of chemicals to be used by students shall be discussed on a day-to-day basis. This discussion shall include the proper safety controls (e.g. engineering controls, work practices) and personal protective equipment used to prevent exposure and proper management of hazardous wastes generated.

C. LABORATORY-SPECIFIC TRAINING

Researchers working in a specific research laboratory shall be provided with laboratory-specific training by the Principal Investigator. At a minimum, this training shall include:

- A lab orientation to familiarize the new researcher with the available safety controls and lab safety rules or work practices;
- Training on all laboratory-specific Standard Operating Procedures (SOPs) relevant to their assigned research tasks or workspaces;
- Management of hazardous waste streams in the laboratory; and
- Emergency procedures and equipment.

IV. HAZARD ASSESSMENT

Chemicals pose many health and safety hazards to researchers as well as to the environment. Recognizing these hazards is integral to developing a plan to control or mitigate the hazards and prevent researcher exposures and injuries.

A. TYPES OF CHEMICAL HAZARDS

Chemical hazards are grouped by hazard type, called hazard classes, and are described using the Globally Harmonized System (GHS) pictograms, as shown in Table 1. The hazard classes and severity of these hazards are defined by manufacturers or importers and listed in the safety data sheet (SDS).

The severity of the hazard within a class is described by the Hazard Category as well as by the combination of a Hazard Code (H-Code) and Hazard Statement. The most severe hazard within a Class is described using the lowest numbered Category and H-Code. For example, the *Acute Toxicity, Oral* class is divided into four categories. Category 1—the most severe—is also described using H-Code H300 and the statement "fatal if swallowed," while Category 4—the least severe—is assigned the H-Code H302 and the statement "harmful if swallowed." A useful poster and summary of GHS pictograms and H-codes is available for free from Sigma-Aldrich.

All Lab Personnel are responsible for recognizing and controlling hazardous chemicals in their lab and research. This means that researchers need to be familiar with the hazards listed on the SDS and have made a plan for how to manage these hazards appropriately (See Section IV.C: Laboratory Hazard Assessment). Examples of chemical Hazard Classes and their associated GHS pictograms is described in Table 1.

Table 1: Health, physical, and environmental hazard pictograms

HEALTH HAZARDS		
Hazard symbol	**Pictogram**	**Hazard Class Examples**
Corrosive		• Skin corrosion/burns • Eye damage • Corrosive to metals
Skull & Crossbones		• Acute toxicity (fatal or toxic)
Health Hazard		• Carcinogen • Mutagen • Reproductive toxicity • Respiratory sensitizer • Target organ toxicity • Aspiration hazard
Exclamation Mark		• Irritant • Skin sensitizer • Acute toxicity (harmful) • Narcotic effects • Respiratory tract irritant • Hazardous to the ozone
PHYSICAL HAZARDS		
Exploding Bomb		• Explosive • Self-reactive • Organic Peroxide

Flame		• Flammable • Pyrophoric • Self-heating • Emits flammable gas • Self-reactive • Organic Peroxide
Oxidizer		• Oxidizers
Gas Cylinder		• Gas under pressure
ENVIRONMENTAL HAZARD		
Environmental Toxin		• Hazardous to the environment • Aquatic toxicity (acute or chronic)

Another common method to communicate hazards is with the National Fire Prevention Association (NFPA) hazard diamond, shown in Figure 1. This system is used to placard a building or room and provides an overview of the hazards contained within. The hazard diamond is broken up into four color-coded hazard sections: red for flammability hazards, yellow for reactivity, blue for health hazards, and white for any special hazards such as water reactive, biohazard, etc. The relative level of hazard is listed on a scale of 1-4, where 4 is the most severe hazard. Note that the numbering system used by NFPA runs counter to the GHS numbering system. For example, a chemical that is "fatal if swallowed" would be listed as a 4 in NFPA and as Category 1; H300 in GHS.

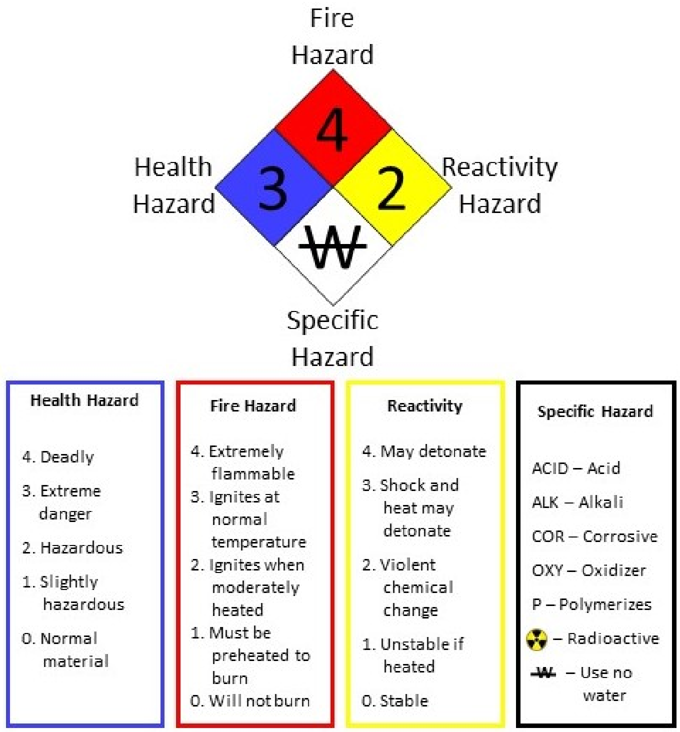

Figure 1: NFPA hazard diamond

B. SAFETY DATA SHEETS (SDS)

Safety Data Sheets (SDSs) are documents that provide health and safety-related information on chemicals, including for commercial products like paint and degreasers. The SDS describes what type of hazards a chemical or mixture poses, what the signs and symptoms of exposure are, and what to do in case of emergency, among many other things.

Principal Investigators are required to ensure that researchers have access to SDSs either electronically or as printed copies. If the SDSs are made available electronically, they must be accessible to all lab members on a network-connected computer terminal (or an equivalent device such as a tablet) inside the area where work is completed. SDSs can be found on the manufacturer's website or via the University's SDS subscription service.

C. LABORATORY HAZARD ASSESSMENT

A laboratory hazard assessment is used to assess the potential risks to researchers working in a laboratory and to evaluate the specific types of personal protective equipment (PPE) needed for work in that laboratory. The Assessment tool from Risk and Safety Solutions shall be used by all labs at SJSU to perform a laboratory-specific assessment of the hazards in the laboratory. Further information on hazard assessments can be found in *Identifying and Evaluating Hazards in Research Laboratories* published by the American Chemical Society. Contact the Chemical Hygiene Officer (408-924-1939) for consultation on completing a laboratory hazard assessment.

V. CLASSES OF CHEMICAL HAZARDS

A. FLAMMABLE AND COMBUSTIBLE LIQUIDS

Most organic solvents and liquid organic chemicals used in research are flammable or combustible liquids. Flammable and combustible liquids are classified based on their flash point, or the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture in air. Flammable liquids have a flash point less than 37.8 °C (100 °F), while combustible liquids have a flash point greater than 37.8 °C (100 °F). Keep in mind that three conditions are *required* for a flammable or combustible liquid to ignite, and controlling or removing one condition (e.g. working in a fume hood) greatly reduces the fire hazard:

1. The concentration of vapor above the liquid must be between the upper and lower flammability limits of the chemical (this range is often defined by upper and lower explosive limit values, UEL and LEL, respectively);
2. An oxidizer (e.g. oxygen in air) must be present; and
3. An ignition source must be present (e.g. Bunsen burner, spark, static discharge, hot surfaces, etc.).

Working with flammable and combustible liquids:

- Use flammable liquids in a properly functioning, certified chemical fume hood or with another source of local ventilation.
- Close flammable liquid containers when not in use.
- Control ignition sources in areas where flammable liquids are in use.
- Properly ground metal surfaces or containers used with flammable liquids to discharge static electricity. Pumps used to transfer highly flammable liquids from bulk containers shall be constructed of metal to bond the pump, container, and receiving flask.
- Never heat flammable liquids over an open flame. Use heating mantles, heating blocks, or water/oil/sand baths.
- Always know the locations of the nearest fire alarms, pull stations, safety showers, and other emergency equipment.
- A fire resistant (FR) laboratory coat must be worn when working with large volumes (> 1 liter) of flammable liquids or during procedures where there is a significant risk of fire (e.g. working with non-trivial amounts of flammable liquids and an open flame or near an ignition source).

B. PYROPHORIC AND WATER REACTIVE MATERIALS

Pyrophoric materials can spontaneously ignite in contact with air or water. Water reactive materials react with water or moisture in the air to produce a toxic gas or a flammable gas that can ignite. Both types of materials must be handled and used in such a way that rigorously excludes air and water, such as in a glove box or with a Schlenk system.

Working with pyrophoric and water-reactive materials:

- Hands-on training that is work and laboratory-specific is required prior to working with these materials.
- Remove all combustible or extraneous material from the area where pyrophoric or water reactive materials will be used.
- Flame resistant (FR) laboratory coats must be worn while working with or handling these materials outside of a properly functioning glove box.
- An appropriate method for quenching the chemicals being used must be identified before beginning work with these materials.
- An appropriate extinguishing material (e.g. sand) must be available in the laboratory and immediately at hand while using these materials outside of a glove-box. Most fire extinguishers are not appropriate or capable of extinguishing a fire from a pyrophoric or water-reactive material.
- Do not use these materials while alone in the laboratory.

A SOP template is available from EH&S for working with pyrophoric materials. Excellent resources for working with pyrophoric and water reactive materials are available from Dow Chemical Company, from Yale University on organolithium reagents, and from UCSD on preparation for pyrophoric reagents, transfer of pyrophoric liquids, and working with reactive metals.

C. REACTIVITY AND STABILITY HAZARDS

Reactive or unstable materials may violently decompose, polymerize, or become self-reactive when initiated by shock, friction, temperature, pressure, light, or contact with other materials, causing a release of large volumes of gas or heat. These materials can be classified as known explosives—materials designed and used for their explosive properties—or as potentially explosive compounds (PECs; e.g. picric acid, organic peroxides, perchlorates, azo compounds). These substances pose an immediate and severe hazard which necessitates all chemical-specific procedures for their storage and use to be carefully reviewed and followed in order to avoid conditions which cause them to become unstable or explosive. Contact the Chemical Hygiene Officer with questions or for help developing safe work practices for reactive and unstable materials.

D. OXIDIZERS

Oxidizers can create a fire or explosion hazard when they are exposed to flammable and combustible materials or other fuel sources. Oxidizers may cause combustion of materials that do not typically burn, may cause combustion in the absence of an ignition source, and may increase the rate and intensity of a fire. These risks may increase as the concentration of oxidizer increases. Oxidizers may react spontaneously or upon slight heating. The National Fire Prevention Association (NFPA) classifies oxidizers using a scale from 1, least hazardous, to 4, extremely hazardous, based on their ability to ignite spontaneous combustion. No NFPA Class 4 oxidizers may be purchased, stored, or used on campus. Purchase, use, or storage of Class 3 materials is strongly discouraged and may require special approval from the Chemical Hygiene Officer.

E. CORROSIVES

Corrosive chemicals can cause immediate and sometimes permanent damage to the skin, eyes, respiratory system, and tissues upon contact. Some chemicals are also corrosive to metals. Both acidic (pH < 4) and basic/alkaline (pH > 10) solutions can cause chemical burns. Many oxidizing agents (e.g. hydrogen peroxide, chlorine) and dehydrating agents (e.g. phosphorous pentoxide, calcium oxide) can also be corrosive. Exposure to corrosive chemicals can produce a variety of symptoms, depending on the route of exposure. Exposure symptoms include:

- Eyes: pain, blood shot eyes, tearing, and blurred vision.
- Skin: redness, pain, inflammation, bleeding, blisters, ulcers, skin discoloration, and burns.
- Respiratory: burning sensation, coughing, wheezing, laryngitis, shortness of breath, nausea, and vomiting.

It is important to review the safety information and reactivity of corrosive materials as these properties can vary widely within this hazard class. Table 2, below, outlines the different corrosive classes and provides examples of corrosive chemicals within the class that are commonly encountered at SJSU.

Table 2: Common corrosive liquid classes

Corrosive Class	Examples
Inorganic acids	• Hydrochloric acid • Hydrofluoric acid • Phosphoric Acid • Sulfuric acid
Inorganic bases	• Ammonium hydroxide • Potassium hydroxide • Sodium hydroxide
Organic acids	• Acetic acid • Formic acid • Trichloroacetic acid
Organic bases	• Hydroxylamine • Tetramethylethylenediamine (TEMED) • Triethylamine
Oxidizing Acids	• Chromic acid • Nitric acid • Perchloric acid

Working with corrosive chemicals:

- Work with corrosive chemicals in a properly functioning chemical fume hood, glovebox, or other local source of ventilation.

- Always work within 10 seconds from a properly-functioning eyewash station and safety shower.
- Keep corrosive chemical containers closed when not in use.
- Add acid in small quantities to water to prevent splattering. Never add water to acid.
- Safety goggles, chemical-appropriate gloves, lab coats, and long pants should be worn when working with corrosives. A chemical-resistant apron should also be considered and is required for working with large volumes of concentrated acids.
- Research involving hydrofluoric acid requires calcium gluconate gel in the immediate work area for emergency use. Expired calcium gluconate solutions **must** be replaced prior to continued use of hydrofluoric acid in the laboratory.
- **Note:** Never use hot or concentrated perchloric acid solutions in a regular fume hood, as perchloric acid fumes will form explosive salts in the fume hood ductwork. Contact the Chemical Hygiene Officer for consultation and approval.

F. COMPRESSED GASES

Compressed gases pose a serious hazard if not handled properly. Damage to the cylinder or its valve can result in a rapid release of energy, making the cylinder into a rocket or fragmentation bomb. Furthermore, a compressed gas poses an asphyxiation hazard due to its ability to rapidly displace the oxygen in a room. Compressed gases may also have chemical-specific hazards (e.g. pyrophoric, flammable, toxic, oxidizing, etc.) which further dictate how they must be managed.

Working with compressed gases:

- The contents of each cylinder must be clearly labeled.
- Cylinders must be capped or attached to a regulator at all times.
- Do not expose cylinders to excessive dampness, excessive heat (> 51 °C/125 °F), corrosive chemicals or flames.
- Gases subject to the Toxic Gas Ordinance are not allowed on campus. These gases have a lethal concentration to 50% of albino rats (LC_{50}) of ≤ 5000 ppm in 1 hour (or approximately ≤ 2500 ppm in 4 hours). Exceptions may be made for a small inventory of lecture bottles for gases with a 1-hour LC_{50} ≥ 200 ppm (e.g. carbon monoxide, chlorine). Contact the Chemical Hygiene Officer for more information and approval.
- Bond and ground all cylinders, lines, and equipment used with flammable compressed gases.
- Electrical equipment used with flammable compressed gases must be designed and approved for such a purpose.

Regulators, piping, and fittings:

- Use only the regulator for the specific gas being used.
- Regulator valves must be kept closed when not in use.
- Never use a leaking, damaged, or corroded regulator.
- Never use Teflon™ tape on Compressed Gas Association (CGA) fittings, as the seal is made by metal-to-metal contact.

- Inspect gas cylinder connections regularly for deterioration and leaks.
- Valves, piping, and fittings must be rated for the pressures, temperatures, and gases being used (e.g. no silver or copper with acetylene or ammonia; no cast iron with chlorine or hydrogen).
- Do not force threads that do not fit.
- Never use lubricants or oil on equipment used with oxygen.
- If pressure relief devices are used with a hazardous gas (e.g. corrosive, flammable), they must be properly vented.

Tubing and hoses:

- Materials used to convey and dispense gases shall be constructed from compatible materials that are designed for the purpose in which they are used.
- Label all gas lines with the chemical name leading from the gas supply.
- Inspect tubing frequently and replace when necessary.
- Tubing and hoses must not be laid across the floor as it creates a trip hazard.
- Avoid sharp bends in copper tubing, as it can crack with repeated bending.
- Do not mix different brands and types of tubing.

G. CRYOGENS

Cryogenic liquids have a boiling point of -90 °C (-130 °F) at one atmosphere (101.3 kPa), making them a severe cold burn/frostbite hazard to unprotected skin and eyes. Cryogenic liquids have a large expansion volume as the cryogenic liquid turns to room-temperature gas, typically greater than 500:1. Rapid gas expansion can cause an explosion if the container is not suitable for holding the pressure due to the gas or when condensed moisture in the air causes a blockage in the cryogen handling system. This rapid expansion property also makes cryogens a severe asphyxiation hazard should the liquid rapidly turn to gas, as is the case in a quenching magnet in an NMR. If gas is rapidly escaping the cryogen dewar or an instrument containing cryogens, evacuate the room, post a warning sign on the door(s) and call SJSU Police Department at (408) 924-2222.

Working with cryogens:

- Do not use cryogenic liquids in a confined space or a space without ventilation (e.g. cold room, closets).
- Pressure relief valves must always be functional and remain unobstructed.
- Prevent contact of combustibles with liquid oxygen or an oxygen-enriched atmosphere.
- Never touch uninsulated pipes or containers holding cryogenic liquids.
- Only use gloves specifically designed for cryogenic liquids while dispensing or transferring cryogenic liquids. These gloves are made for incidental contact only and immersion can cause frostbite or permanent tissue damage. Routinely inspect gloves for any holes or tears and discard damaged gloves.
- A face shield should be worn while dispensing or transferring cryogens.

H. PARTICULARLY HAZARDOUS SUBSTANCES (PHSs)

The Cal/OSHA laboratory standard requires that laboratory workers take particular care and caution while working with Particularly Hazardous Substances (i.e. carcinogens, reproductive toxins, and chemicals with a high degree of acute toxicity). Laboratory-specific Standard Operating Procedures (SOPs) for these materials are required in order to prevent exposure to Laboratory Personnel, and must include the following provisions:

1. Establishment of a designated area,
2. Use of containment decides such as chemical fume hoods or gloveboxes,
3. Procedures for safe removal of contaminated waste, and
4. Decontamination procedures.

Principal Investigators overseeing Lab Personnel using carcinogens, reproductive toxins, and acutely toxic chemicals are responsible for Lab Personnel training, providing appropriate personal protective equipment, and approval of procedures using Particularly Hazardous Substances in their laboratories. Laboratory Personnel are responsible for following all laboratory-specific procedures designed for the safe use of Particularly Hazardous Substances.

1. CARCINOGENS

Carcinogens are substances or a mixture of substances that cause cancer or tumor development, typically after repeated or chronic exposure. Their effects may only become evident after a long latency period and generally with no immediate harmful effects after an exposure. A SOP template for working with carcinogens is available from EH&S.

A chemical or substance is classified as a carcinogen if it meets one of the following criteria:

- It is a regulated Cal/OSHA carcinogen, as described in Title 8 of the California Code of Regulations (8 CCR), Article 110, Sections 5200-5220.
- It is listed by the National Toxicology Program (NTP) Annual Report on Carcinogens in the groups “known to be a human carcinogen” or “reasonably anticipated to be a human carcinogen.”
- It is listed by the International Agency for Research on Cancer (IARC) Monographs; listed in Groups 1, 2A, or 2B.
- It causes statistically significant tumor incidence in experimental animals under defined conditions, as defined in 8 CCR section 5191.
- It is noted on the Safety Data Sheet that a chemical or mixture is a carcinogen using the Globally Harmonized System (GHS) Hazard code H350 (Category 1A, 1B; may cause cancer) or H351 (Category 2; suspected of causing cancer).

Note that carcinogens listed in 8 CCR, Article 110, Section 5209, called “Listed Carcinogens,” may not be purchased, stored, or used at SJSU.

2. REPRODUCTIVE TOXINS

Reproductive toxins are substances or a mixture of substances that may affect reproductive capabilities. This includes adverse effects on sexual function and fertility, effects on fetuses (teratogenesis), or chromosomal damage (mutagenesis). For women, exposure to reproductive toxins during pregnancy can cause adverse effects on the fetus, including embryo lethality (death of fertilized egg, embryo, or fetus), malformations (teratogenic effects), postnatal defects, and effects via lactation. For men, exposure can lead to sterility. A SOP template is available from EH&S for work with reproductive toxins.

Reproductive toxins are indicated by the Safety Data Sheet of a chemical or mixture with the following Globally Harmonized System (GHS) hazard codes:

- H340 (Category 1A, 1B): May cause genetic effects, mutagen
- H341 (Category 2): Suspected of causing genetic effects, mutagen
- H360 (Category 1A, 1B): May damage fertility or the unborn child, reproductive toxin. H360 may be further modified to specify the target of toxicity:
  - H360F: May damage fertility
  - H360D: May damage the unborn child
  - H360FD: May damage fertility. May damage the unborn child.
- H361 (Category 2): Suspected of damaging fertility or the unborn child, reproductive toxin. H361 may be further modified to specify the target of toxicity:
  - H361f: Suspected of damaging fertility
  - H361d: Suspected of damaging the unborn child
  - H361fd: Suspect of damaging fertility. Suspected of damaging the unborn child.
- H362: May cause harm to breast-fed children, effects via lactation

3. ACUTE TOXINS

OSHA considers substances with a high degree of acute toxicity to be those that "may be fatal or cause damage to target organs as the result of a single exposure or exposures over a short duration." Acute toxins are categorized by the amount of toxin that causes 50% mortality in test animals (Lethal dose, 50% mortality: LD_{50}; lethal concentration, 50% mortality: LC_{50}). Acute toxins with a high degree of toxicity must be managed as Particularly Hazardous Substances, all other acute toxins should be evaluated by the Principal Investigator. All empty chemical containers that previously held chemicals with a high degree of acute toxicity must be disposed of as hazardous waste. A SOP template is available from EH&S for working with acutely toxic solids and liquids.

Acute toxins with a high degree of toxicity can be identified using one of the following criteria, which are listed in the Safety Data Sheet:

- Globally Harmonized System (GHS) hazard codes H300 (Category 1 and 2; fatal if swallowed), H310 (Category 1 and 2; fatal in contact with skin), H330 (Category 1 and 2, fatal if inhaled).

- Oral LD_{50} of 50 mg/kg or less in rats
- Dermal LD_{50} of 200 mg/kg or less when administered by continuous contact for 24 hours in rabbits
- Inhalation LC_{50} of 200 ppm by volume or 2 mg/L of mist, fume, or dust when administered by continuous inhalation for 1 hour in rats.

I. SENSITIZERS

A sensitizer, or allergen, is a substance that causes exposed individuals to develop an allergic reaction after repeated exposure to the substance. Common examples include diazomethane, chromium, nickel, formaldehyde, isocyanates, benzylic and allylic halides, many phenol derivatives, and latex proteins. Exposure to sensitizers can lead to symptoms associated with allergic reactions and can exacerbate an individual's existing allergies.

J. IRRITANTS

Irritants are non-corrosive chemicals that cause reversible inflammatory effects on tissue (eyes, skin, lungs, etc.) at the site of chemical contact. Symptoms often include reddening or discomfort of the skin and irritation to the respiratory system. Care should always be taken to avoid chemical contact or inhalation. Work practices must be designed to minimize exposure to these materials to prevent development of an allergic response.

K. NANOMATERIALS

Nanomaterials include any materials or particles that have an external dimension in the nanoscale (approximately 1–100 nanometers). Nanomaterials occur naturally in the environment, are products of combustion, and can be created by chemical synthesis. Synthesized nanomaterials are referred to as Engineered Nanomaterials.

Nanomaterials are categorized by the risk of potential exposure to Laboratory Personnel, which is impacted by physical state, surface area, and how they are used. Dry or powdered nanomaterials pose the greatest risk, while those bound to a solid matrix pose the least risk. Principal Investigators using nanomaterials in their research must define a combination of engineering controls, standard operating procedures (SOPs), and personal protective equipment to minimize exposures of their researchers working with nanomaterials.

Helpful resources for developing a nanomaterial control plan and SOPs include:

- "Nanotoolkit: Working Safely with Engineered Nanomaterials in Academic Research Settings" published by the California Nanosafety Consortium of Higher Education
- "General Safe Practices for Working with Engineered Nanomaterials in Research Laboratories" published by the National Institute of Occupational Safety and Health (NIOSH)
- Dow Chemical's nanoparticle safety video
- A compilation of Resources for Nanotechnology Laboratory Safety is available from the National Nanotechnology Initiative

VI. INVENTORY, LABELING, STORAGE, AND TRANSPORT

A. CHEMICAL PROCUREMENT

Chemicals must be procured by a purchase request through Business Services, the Research Foundation, or the Tower Foundation. Principal Investigators ordering a chemical for the first time (i.e. the chemical will be new to their lab; never purchased by them previously) must fill out a Hazardous Materials Request Form. The goal of this procurement process is to ensure the proper safety controls are available and in place to use the requested material safely.

B. CHEMICAL INVENTORY

All hazardous chemicals at SJSU are managed using an online chemical inventory database. All chemicals on campus must be entered into the inventory system upon receipt. Chemicals that have been used up or are disposed of must be removed from the inventory database. Care should be taken to consult the inventory system to ensure duplicate or excess chemicals are not ordered.

C. CHEMICAL LABELING

All chemicals and non-empty containers in the laboratory must be labeled, regardless of whether or not the chemical is hazardous. Chemical labels that have degraded, been removed, or that have fallen off must be replaced. Hazardous chemicals must have their containers properly labeled with the hazards associated with a chemical. Chemicals purchased from the manufacturer will contain this information, however chemicals transferred to a new container, called a secondary container, will not. Chemicals in a secondary container—such as a squirt bottle, flask, or vial—must be labelled with their associated hazards. Container labels must include:

- Full name, in English.
- Hazards associated with the chemical, if applicable. Hazards may be expressed as:
  - A written word (e.g. “Toxic” or “Carcinogen”),
  - With the corresponding Globally Harmonized System (GHS) pictogram, or
  - Using the appropriate National Fire Prevention Association (NFPA) placard.
- Date the chemical was received and opened, which is required for peroxide forming chemicals and highly recommended for all others.

D. LABORATORY/ROOM LABELING

Each laboratory must have the following information posted on the exterior door(s) of the laboratory in case of emergency:

- The Principal Investigator’s name and contact information
- A safety contact within the College (e.g. the College Safety Coordinator)
- The hazards contained within the lab, noted with either Globally Harmonized System Pictograms (Table 1) or using the National Fire Prevention Association (NFPA) hazard

diamond (Figure 1). Other, non-chemical hazards, such as biohazards or radiological hazards, must be listed on the door as well.

The minimum personal protective equipment (PPE) required within the space can be a helpful addition to the laboratory door sign, as shown in Figure 2. A SJSU door sign template is available to aid the design of lab-specific signage.

Figure 2: Example laboratory door sign.

E. CHEMICAL SEGREGATION AND STORAGE

1. GENERAL RECOMMENDATIONS

- A clearance of 18 inches must be kept from the ceiling.
- Avoid storing materials on top of cabinets.
- Chemicals should be stored inside of appropriate cabinets with doors that close. Open shelving must have a raised lip along the outer edge or a railing to prevent chemicals from falling.
- Chemical shelving must be securely attached to a wall.
- Chemicals should be stored away from heat or direct sunlight.

- Always store corrosive or acutely toxic chemicals below five feet in chemically-compatible secondary containment.
- Fume hoods should not be used for chemical storage.
- Chemicals should not be stored on benchtops or on the floor.
- Chemical refrigerators and freezers must be labeled with "No food/drink" and never used to store items for human consumption.
- Off-specification, expired, or other chemicals with no useful purpose to the lab should be disposed of through EH&S.

A chemical segregation strategy must be employed that ensures incompatible chemicals are not stored together. Simply alphabetizing chemicals or storing them by the number of carbon atoms in the molecule without consideration to their chemical properties is not sufficient. Implementation of the storage method described in Figure 2 is ***strongly*** recommended. This storage method was developed by Stanford University and is the recommended method described in *Prudent Practices in the Laboratory* published by the National Academy of Sciences.

- Like chemicals, or Chemical Storage Groups should be stored in separate cabinets or storage areas, if at all possible.
- If storing each Chemical Storage Group separately is not an option due to space limitations, Figure 2 provides guidance on how to store the chemicals in the same cabinet in chemically-compatible secondary containment.
- Chemicals in Storage Group X cannot be stored with other chemicals in Group X.
- Examples of chemicals belonging to each Storage Groups can be found in *Prudent Practices in the Laboratory* or from Princeton University.

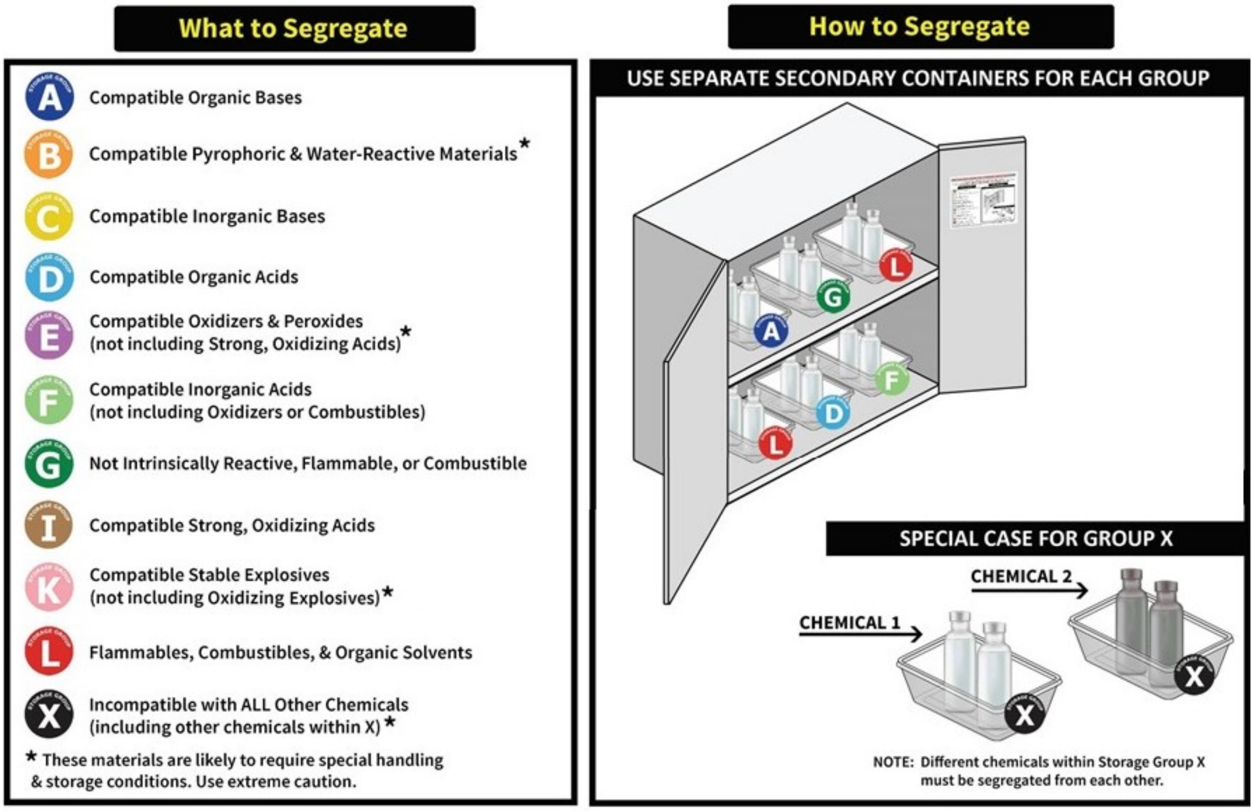

Figure 3: Chemical segregation guidance.

2. FLAMMABLE AND COMBUSTIBLE LIQUIDS

- Flammable liquids (Storage Group L) should be stored in rated flammable materials storage cabinets when not in active use.
- No more than 10 gallons of flammable liquids may be stored outside of a rated flammable storage cabinet in the laboratory. This limit includes any flammable/combustible hazardous wastes inside the laboratory.
- Storage of flammable or combustible liquids may not exceed 60 gallons (227 liters) of flammable liquids or 120 gallons (454 liters) of combustible liquids in any one flammable storage cabinet.
- Vent openings in flammable storage cabinets shall either be connected to the building exhaust ventilation system or shall be sealed with bungs.
- Cabinets where flammable materials are stored at a minimum must be labelled with the word “Flammable.”
- Flammable material storage areas must be free of ignition sources (e.g. electrical outlets, open flames, hot surfaces, etc.).
- An approved flammable material storage refrigerator or freezer must be used if flammable liquids need to be stored at reduced temperature. Standard domestic refrigerators or freezers contain multiple ignition sources within the unit which create a severe fire hazard.

- Never store paper, cardboard, Styrofoam, or other combustible materials with flammable or combustible liquids.
- Quantities of stored flammable and combustible materials must comply with California Fire Code.
- Storage of flammable liquids must not block any route of egress (emergency exit route).

3. PYROPHORIC AND WATER REACTIVE MATERIALS

Pyrophoric materials can ignite in the presence of water or air. Water reactive materials react with moisture in the air to produce a toxic gas or a flammable gas which can then ignite. Both of these materials fall into Storage Group B.

- Store these materials in a way that rigorously excludes air and moisture, such as in a desiccator under inert atmosphere or in a glove box.
- Refrigerators and freezers rated for flammable liquids storage must be used when these materials need to be stored at reduced temperature.
- Do not store pyrophoric or water reactive materials in a flammable materials storage cabinet with flammable liquids.
- Pyrophoric or water reactive materials shipped with special storage containers (e.g. Aldrich Sure/Seal™) should be carefully maintained to ensure they are kept air-free.
- Ensure adequate protective storage material is maintained for reagents stored under kerosene, solvent, mineral oil, or inert gas.

4. OXIDIZERS

Oxidizers (Storage Group E, e.g. hydrogen peroxide, potassium permanganate, etc.) should be stored in a cool, dry place and segregated from flammable and combustible materials (e.g. wood, Styrofoam, cardboard, plastics, etc.) and reducing agents (zinc, alkaline metals, metal hydrides, etc.).

5. PEROXIDE-FORMING CHEMICALS (TIME-SENSITIVE MATERIALS)

Peroxide-forming chemicals (e.g. ethers, alkenes, alkynes, etc.) should be stored in airtight containers protected from light, heat, and moisture, and stored with compatible chemicals. These chemicals can become a serious explosion hazard if not maintained properly. Follow these guidelines for peroxide storage:

- Always store peroxide-forming chemicals in the original manufacturer's container.
- Label and mark the container with the date received and the date opened.
- Only purchase the amount of peroxide-forming materials that will be used by their expiration date.
- Test these materials for peroxide formation periodically and document results at least annually.
- In general, use or dispose of peroxide-forming materials within 18 months of purchase if unopened or 1 year if opened. Dispose of Class A peroxide formers (e.g. isopropyl ether, sodium amide) within 3 months.

DO NOT handle the container if:

- Crystallization is present on the exterior of the container.
- The liquid in the container contains solids, appears cloudy, or has separated into multiple liquid layers.
- An old container of peroxide-forming chemical is discovered in the laboratory (greater than 5 years beyond the expiration date or the age is unknown).

If you encounter a suspicious container, secure the area to restrict access to the container until it can be evaluated by EH&S.

6. CORROSIVES

- Store corrosive chemicals below eye level (five feet or less).
- Store corrosive materials in a corrosives cabinet.
- Store corrosives in chemically-compatible secondary containment. Containment must be large enough to contain at least 110% of the total volume of liquid stored within or the total volume of the largest container, whichever is greater.
- Segregate acids from bases, then further segregate organic from inorganic materials.
- Acids must always be segregated from:
  - Bases and reactive metals (e.g. sodium, potassium, magnesium).
  - Chemicals that could generate toxic gases upon contact (e.g. sodium cyanide, sodium azide).
  - Mineral acids (inorganic acids) must be segregated from organic acids.
  - Oxidizing acids (Storage Group I, e.g. chromic acid, nitric acid, perchloric) must be segregated from flammable and combustible materials, and preferably from all other materials.

7. ACUTELY TOXIC MATERIALS

Acutely toxic chemicals should be stored based on their other hazards and physical properties. These chemicals should be stored in secondary containment in a well-ventilated area and never stored higher than eye level (~5 feet).

8. COMPRESSED GASES

- Cylinders must be capped or attached to a regulator at all times.
- Cylinders shall be segregated by hazard class.
- Secure cylinders upright to a substantial, fixed surface (e.g. to the studs within a wall) using restraints made of non-combustible materials such as chains.
- Secure cylinders to or within a rack, rail framework, or similar assembly designed to store compressed gas cylinders.
- Two cylinder restraints (e.g. chain) must be used and placed at roughly 1/3 from the top and 1/3 from the bottom of the cylinder. Restraints must be relatively taught (i.e. not loose).
- Segregate empty and full gas cylinders.

- Keep the number of cylinders to a minimum.
- Oxidizing gases must be stored 20 feet from flammable materials (e.g. hydrogen), or separated by a fire wall.
- Never store more than two cylinders using one set of chains. One set of chains per cylinder is preferred.

F. CHEMICAL TRANSPORT

1. ON-CAMPUS TRANSPORT

Chemicals will be delivered directly to Distribution Services, then to central delivery areas within the Colleges and/or to specific laboratories. When chemicals need to be transported throughout a building or across campus to a different location, the following precautions must be taken to prevent spills or breakage:

- Secondary containment must be used during transport.
  - Containment must be large enough to contain the contents of the bottle(s) being transported should the container(s) break or rupture.
  - Secondary containers must be durable and leak resistant.
- Chemicals must be tightly sealed prior to transport. NEVER transport a container without a properly fitted lid.
- Do not leave chemicals unattended during transport.
- Sturdy carts and secondary containment must be used when transporting multiple, heavy, and/or large containers.
- Use elevators (preferably freight elevators) for chemical transport. Avoid transporting chemicals on the stairs.
- Contact EH&S prior to moving large quantities of chemicals to ensure compliance with local, state, and federal regulations.
- When transporting compressed gas cylinders, always secure the cylinder to a suitable hand truck with a strap or chain. A safety cap shall be used for transport to protect the cylinder valve. Never transport a cylinder with the regulator attached. Never transport a cylinder horizontally. To prevent tipping, always push (never pull) a cylinder on a dolly or a dewar.

2. OFF-CAMPUS TRANSPORT OR SHIPMENT

Transportation of hazardous chemicals and compressed gases over public roads or by air is governed by international, federal, and state regulatory agencies. These agencies include the U.S. Department of Transportation (DOT) and the International Air Transport Association (IATA). Any shipment of hazardous materials must ensure compliance with all pertinent regulations.

VII. CONTROLLING WORKPLACE HAZARDS

Hazardous chemicals require a carefully considered, multi-tiered approach to effectively manage associated health risks. There are four primary routes of exposure for chemicals:

- Inhalation – breathing in chemical fumes or fine particles.
- Absorption – chemical contact with the skin or eyes.
- Ingestion – eating or drinking contaminated items in the lab.
- Injection – skin punctured by a contaminated sharp or chemical uptake by an open wound.

Of these routes, inhalation is the most common route of exposure within the lab, though all routes of exposure are possible in the laboratory without appropriate safety controls and good laboratory hygiene. A series of safety controls must be implemented in order to prevent exposure to hazardous or potentially hazardous situations in laboratories. The hierarchy of controls (Figure 3) is a system that describes control strategies in descending order from most effective to least effective.

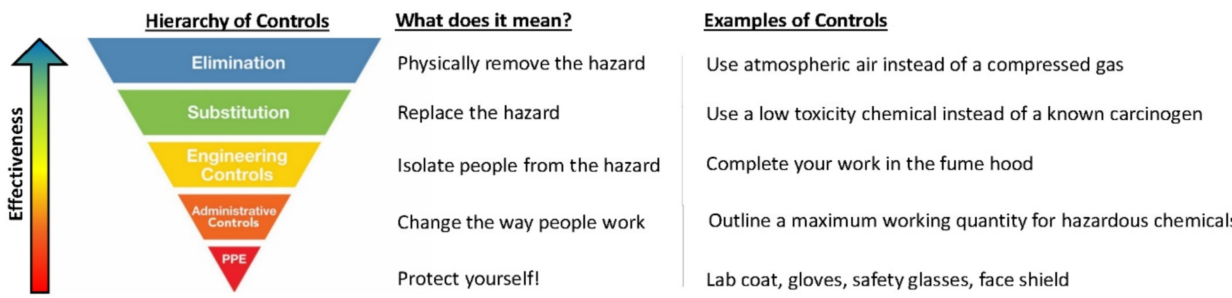

Figure 4: Hierarchy of controls.

The primary methods for reducing researcher exposure to workplace hazards is to design the hazard out (*elimination*), *substitute* the hazard with something less toxic or hazardous, or by isolating the hazard away from the researcher using *engineering controls* (e.g. ventilation or enclosing the operation). If such controls are not feasible or cannot alone reduce the potential exposure to acceptable levels (as is often the case), appropriate *administrative controls* and *personal protective equipment (PPE)* must be used to minimize exposures, preferably in conjunction with *engineering controls*. Applying the hierarchy of controls in a layered approach provides the most protection to exposures that cannot be eliminated or designed out.

A. ENGINEERING CONTROLS

Engineering controls are used to control hazards at their source by designing the work area or job itself to eliminate or reduce exposure to hazards. Following *elimination* and *substitution*, these controls provide the first line of protection to prevent exposure to hazardous chemicals. Examples of engineering controls commonly encountered in the laboratory include chemical fume hoods, gloveboxes, general room exhaust, “snorkels,” flammable material storage equipment, machine guarding, and downdraft tables.

1. FUME HOODS

Chemical fume hoods are the most common and most important engineering control used in the laboratory. Fume hoods are certified annually by EH&S or the College Safety Team. All procedures that generate irritating or hazardous air contaminants (e.g. flammable chemical fumes, acutely toxic chemical fumes, etc.) must be conducted inside of the fume hood or other suitable enclosure (e.g. glovebox). To ensure proper function and protection, the following work practices must be followed while working in chemical fume hoods:

- Keep all chemicals and apparatuses at least **6 inches** back from the front face of the fume hood. This ensures any fumes are drawn into the hood rather than out of the fume hood and into the researcher's breathing zone.
- Do not store unnecessary chemicals, apparatuses, or other items in the fume hood.
- Keep the fume hood sash closed as much as possible. The **sash height shall never exceed 18 inches** from the work surface (with the rare exception of apparatus set-up). For hoods with horizontal sash panels, at least one panel must be placed between the researcher and their work in the hood (i.e. arms are wrapped around the sliding panel).
- Do not use the hood to volatilize or evaporate chemicals or wastes.
- Keep slots in the fume hood baffles free of obstruction. The baffles are an essential part of fume hood exhaust and function.
- Never use electrical outlets inside of the fume hood. Always run equipment cords to outlets outside of the fume hood.
- Elevate equipment (e.g. centrifuge, balance) at least two inches off the fume hood benchtop. Equipment placed on bench surface can obstruct airflow to exhaust.
- Fume hoods must be turned on and remain functional at all times while chemicals are in the hood.
- Keep the hood sash closed when not in use.
- Never work in a fume hood that is not functioning properly. Remove all chemicals from the fume hood, close the sash, and contact the EH&S or Facilities Work Control (408-924-1950) to initiate a work order.

NOTE: Perchloric acid should not be used in a standard chemical fume hood, due to its ability to form explosive perchlorate salts in the ductwork. Contact the Chemical Hygiene Officer prior to using any heated or concentrated perchloric acid in a chemical fume hood.

2. GLOVEBOXES

Gloveboxes are designed to provide a contained, specialized atmosphere for hazardous materials that are sensitive to air, water vapor, or other contaminants found in air. Depending on the material in use, failure of the glovebox that results in exposure to air contaminants can lead to rapid degradation or violent reactions. The following practices must be followed for working with gloveboxes:

- The Principal Investigator must ensure that all personnel are trained to work with the glovebox prior to its use. Training should be documented.
- The Principal Investigator is responsible for ensuring that the glovebox and all associated equipment (e.g. vacuum pumps, solvent scrubbers, oxygen sensors, etc.) have been installed and maintained according to manufacturer specifications.

- Inspect windows, gloves, vacuum pump, lines, and connections for signs of damage or deterioration prior to each use.
- Wear chemical-appropriate disposable gloves (e.g. nitrile) on the glovebox gloves to extend the lifetime of the glovebox gloves and to avoid cross contamination.
- Ensure there are back-up procedures in place in case of loss of building power or a required compressed gas. These procedures must be documented.

3. OTHER TYPES OF VENTILATION

In addition to chemical fume hoods and gloveboxes, other sources of ventilation may be present in labs. Some of these provide local exhaust ventilation to remove hazardous fumes from the researcher's breathing zone, such as elephant trunks (or "snorkels") and downdraft tables. There are also ventilation systems designed to protect samples or products from contamination, including biosafety cabinets and laminar flow benches (or "clean benches"). Biosafety cabinets are designed to protect the product, the worker, and the environment from contamination with particulates or biohazards, however they provide no protection from hazardous chemical fumes. Laminar flow benches protect only the product from contamination and are not to be used with hazardous materials.

B. ADMINISTRATIVE CONTROLS

Administrative controls are policies, work practices, and procedures designed to limit exposures to laboratory hazards. Administrative controls are often used in conjunction with engineering controls and personal protective equipment to provide a holistic exposure prevention program. Common examples of administrative controls include:

- Training
- Policies to limit risk of exposure
- Standard operating procedures (SOPs)
- Good housekeeping
- Routine maintenance of equipment
- Signs and labels

Principal Investigators may implement additional administrative controls specific to their labs, beyond the guidelines outlined in this Chemical Hygiene Plan. Lab-specific training and other lab-specific procedures must be conveyed to research personnel before they begin research.

1. WORKING ALONE IN LABS

No work may be done alone in an immediately hazardous environment, which involves work with any material, activity, or circumstance that could cause an individual to become incapacitated and render them unable to seek assistance. Examples include work with poisons or toxic gases at a level approaching the threshold to be considered Immediately Dangerous to Life and Health (IDLH), or work with explosive or pyrophoric compounds. In this case, "alone" means that there is not another individual in visual or audible range that can provide assistance to the individual engaged in the hazardous research activity.

Principal Investigators are encouraged to define the types of procedures and/or equipment in their laboratories that cannot be used while researchers are alone in the laboratory and train their Lab Personnel on these lab-specific rules.

2. RESEARCH APPROVAL

Principal Investigators are strongly encouraged to establish rules for the following activities and chemical usage in their laboratory operations that involve an increased level of risk:

- Working alone in the laboratory.
- Working with highly hazardous materials (e.g. pyrophorics, hydrofluoric acid, toxic gases, chemicals with a high degree of acutely toxicity/poisons, potentially explosive compounds).
- Modifying a procedure in such a way that it substantially increases the overall hazard (e.g. reaction scale-up, change in reaction pressure or temperature, etc.).

3. LABORATORY-SPECIFIC STANDARD OPERATING PROCEDURES (SOPs)

Laboratory-specific Standard Operating Procedures (SOPs) are detailed documents that describe the hazards associated with a chemical, class of chemicals, or process and the appropriate safety controls required for working with the hazard. While general guidance regarding laboratory work is provided in this Chemical Hygiene Plan, Principal Investigators are required to develop and implement laboratory-specific SOPs for hazardous chemicals that are used in the laboratory. Laboratory-specific SOPs must provide enough detail so that individuals with limited experience can carry out the procedure or process safely. Specific attention must be paid to chemicals with a high degree of acute toxicity, reactivity (e.g. explosives, pyrophorics, etc.) and other chemicals that can cause harm after a single or repeated exposure (e.g. carcinogens, reproductive toxins).

Each laboratory-specific SOP must include the following elements, at a minimum:

Table 3: Required Lab-Specific Standard Operating Procedure Elements

Section	Section Title
1	Hazard Overview
2	Engineering/Ventilation Controls
3	Administrative Controls
4	Personal Protective Equipment
5	Spill and Emergency Procedures
6	Waste Management
7	Decontamination
8	Designated Area
9	Detailed Protocol(s)
10	Approval and Signatures

To aid in the generation of laboratory-specific SOPs, EH&S has developed SOP templates for work with acutely toxic solids & liquids, carcinogens, hydrofluoric acid, pyrophorics, and reproductive toxins. A blank SOP template, a general SOP guidance document, and other SOP authoring resources are available on the EH&S website.

C. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal protective equipment (PPE) is a researcher's last line of defense against chemical exposures. At a minimum, long pants (covered legs) and closed toe/closed heel shoes (covered feet) are required to enter a laboratory where hazardous chemicals are used or stored. While working with or adjacent to hazardous chemicals, protective gloves, a laboratory coat, and protective eyewear should be worn. Careful consideration must be made to fit and comfort; uncomfortable or ill-fitting PPE often does not provide adequate protection and is less likely to be worn. Table 4–Table 6 provide guidance to help select the appropriate PPE for the types of hazards encountered in the laboratory environment.

Safety eyewear (Table 4) should always be worn in the laboratory, since the dynamic environment of the laboratory makes it hard to define where accidents *won't* happen. Safety eyewear must conform to the American National Standards Institute (ANSI) standard Z87.1, which ensures impact resistance. Safety or "splash" goggles with indirect ventilation are recommended when handling corrosive chemicals, when splashes are foreseeable, when generating aerosols, or when working with hot liquids over 60 °C (140 °F). A face shield should be paired with either safety glasses or goggles, depending on the situation.

Table 4: Eye and face protection types.

Eye/face Protection Type	Use Examples
Safety glasses	Impact resistance, small incipient splashes
Safety goggles	Procedures where splashes are foreseeable, generating aerosols, working with corrosive liquids, or liquids over 60 °C (140 °F)
Laser safety eyewear	Working with or around active Class 3B or 4 lasers
Prescription glasses	NOT sufficient for eye protection, unless they meet the ANSI Z87.1 standard and have compliant side shields
Face shield	Work with large volumes of corrosive chemicals or cryogens

Lab coats should always be worn and buttoned closed while working with hazardous chemicals, as illustrated by this laboratory injury video from UCSD. Other types of body protection can provide specialized protection from specific hazards, such as wearing a chemically-resistant apron when working with corrosive liquids or acute toxins that can easily be absorbed by the skin. Body protection is described in Table 5.

Table 5: Types of body protection.

Body Protection Type	Use Examples
Standard lab coat	General lab work not involving risk of fire

Flame-resistant lab coat	Working with chemicals where risk of fire is present (e.g. flammable liquids with open flame or ignition source, pyrophorics)
Barrier lab coat	Provides some liquid resistance; used for work with biohazards or blood borne pathogens
Chemically-resistant apron, vests, or sleeves	Working with chemicals that are corrosive and/or toxic by skin contact/absorption where splashes are foreseeable
Slip resistant shoes	Working in areas with wet floors

Selecting appropriate gloves for research is both chemical and activity specific. No one type of glove will protect against all chemical hazards, and a combination of gloves may be needed to confer resistance to all chemicals used in a specific experiment. The length of contact time (incidental vs. immersion) must also be considered when selecting gloves for a specific task. Double-gloving and frequent glove changes should be considered when working with high-hazard materials (e.g. hydrofluoric acid) or with materials where the glove compatibility properties are poor or unknown. Polyvinyl chloride and latex gloves provide poor chemical protection and should not be used.

The following resources can be used to determine the appropriate glove for the chemical(s) being used:

- The Safety Data Sheet can be used to identify a glove type that has been tested against the chemical and the recommended contact time for that glove type.
- Table 6 provides a summary of glove chemistries and their advantages, disadvantages, and types of chemicals they are compatible with.

Table 6: Types of chemical resistant gloves

Type	Advantages	Disadvantages	Use with
Butyl rubber	Extended contact possible	Poor vs. hydrocarbons, chlorinated solvents	Polar organics (e.g., glycol, ethers, ketones, esters)
Neoprene	Extended contact possible, medium chemical resistance, medium physical properties, do not support combustion	Poor for halogenated and aromatic hydrocarbons	Good for acids, bases, alcohols, fuels, peroxides, hydrocarbons, and phenols
Nitrile	Excellent physical properties, dexterity	Incidental contact only, poor vs. benzene, methylene chloride, many ketones	Oils, greases, petroleum products and some acids and bases, fair vs. toluene
Polyvinyl alcohol (PVA)	Resists a very broad range of organics, good physical	Cannot be used with water or water-based solutions, poor vs. light alcohols (e.g.,	Aliphatics, aromatics, chlorinated solvents, ketones (except acetone), esters, ethers

	properties, specific-use glove	methanol, ethanol)	
Fluoroelastomer (Viton)	Extended contact possible, organic solvents, good resistance to cuts and abrasions	Poor physical properties, poor vs. some ketones, esters, amines	Aromatics, chlorinated solvents, also aliphatics and alcohols
Norfoil	Extended contact possible, excellent chemical resistance	Poor fit, easily punctures, poor grip, stiff	Good for most hazardous chemicals

Respiratory protection may be required for some specialized work (e.g. animal care) or when responding to spills outside of a chemical fume hood. If your work requires respiratory protection to complete it safely, you must undergo fit testing and training, as is required by the SJSU Respiratory Protection Program. If you have questions or need a consultation of your work, contact the Chemical Hygiene Officer. Use of a dust mask for comfort purposes that is neither required by the Principal Investigator nor required to complete the work safely is considered "voluntary use" and is exempt from the respiratory protection program.

VIII. GENERAL LABORATORY SAFETY AND HYGIENE

A. GENERAL REQUIREMENTS

- Unauthorized individuals are not allowed in laboratories. Access is limited to SJSU Lab Personnel and visitors with legitimate reasons for being in a specific laboratory.
- Pets are not allowed in laboratories, with limited exceptions for police dogs and service animals (e.g. guide dogs). The only live vertebrate animals allowed in labs are those assigned to an active research or teaching protocol approved by the Institutional Animal Care and Use Committee.
- No food or drinks designated for human consumption are allowed in the laboratory.
- Know procedures for emergencies, including how to use emergency equipment and evacuation routes.
- Do not use broken or malfunctioning safety equipment (e.g. chemical fume hood). Call Facilities Work Control (408-924-1990) or the Chemical Hygiene Officer (408-924-1939) to initiate a work order.
- Always label all secondary containers (e.g. beaker, flask, vial, squeeze bottle, etc.) and samples with chemical name(s) and hazard class(s), if applicable.
- A first aid kit should be available for emergency use.
- Use spill trays under equipment to catch accidental spills or overflow of liquids (e.g. under a high vacuum pump).
- Report accidents, spills, or other emergencies to the Principal Investigator and EH&S (408-924-1969).

B. PERSONAL HYGIENE

- Do not eat, drink, smoke, chew gum, or apply cosmetics in laboratories (where hazardous chemicals are used or stored).
- Do not store food, beverages, tobacco, or cosmetic products in laboratories.
- Never touch hazardous chemicals without appropriate hand protection.
- Never attempt to smell, inhale, or taste a hazardous chemical.
- Do not reuse disposable gloves.
- Never use mouth suction to pipet.
- Secure loose-fitting jewelry.
- Tie back and secure long hair.
- Lab coats, gloves, and other personal protective equipment (PPE) are not allowed outside of non-lab areas (e.g. restrooms, cafeteria). PPE may be worn when walking from one area of a laboratory building to another, especially when transporting hazardous chemicals, however one hand must ALWAYS remain ungloved to touch common surfaces (e.g. doorknobs, elevator buttons, etc.).
- Wash hands thoroughly with soap and water after handling hazardous chemicals and before leaving the laboratory.
- Wash affected areas promptly whenever a chemical has come in contact with the skin. See Section X: Emergency and First Aid Procedures for more details.
- Contaminated clothing and other reusable PPE must be laundered by an approved vendor. Contaminated clothing must not be taken home for laundering. Grossly contaminated PPE must be disposed of as hazardous waste.
- All contaminated materials and equipment must be decontaminated before reuse.

C. HOUSEKEEPING

- Fire alarms, fire extinguishers, electrical panels, first aid kits, safety showers, eyewash stations, and all other safety-related equipment must remain unobstructed and be appropriately marked/labeled.
- Aisles, hallways, and stairs must be kept clear of chemicals, equipment, and other debris.
- Lab benches, floors, shelving, and equipment must be kept clean and orderly and in a sanitary condition.
- Do not clutter benches or other work surfaces; only keep the materials for the experiment at hand on the work surface.
- Lab benches and equipment must be cleaned and/or decontaminated at the end of each experiment and at the end of each day.
- Whenever possible, laboratory doors should remain closed to minimize the spread of chemical vapors, pathogens, or smoke in case of an accident. Closed doors also prevent laboratory access by unauthorized individuals.
- All materials in the laboratory, such as chemicals, wastes, equipment, cords, must be stored in such a way that it does not create a hazard for those working in the laboratory.

- Storage of flammable and combustible materials (e.g. rags, cardboard, paper, etc.) must be kept to a minimum.
- Lab equipment must be regularly inspected, maintained, and repaired when necessary.
- Floors must remain clean and dry.
- Floors must be clear of obstructions that could pose a slip, trip, or fall hazard.
- Vacuum equipment must be trapped or filtered.
- Spills must be cleaned up immediately.
- All belts, pulleys, fans and other moving parts must be properly guarded.
- Space heaters are not allowed in laboratories.

D. ELECTRICAL SAFETY

1. ELECTRICAL BOXES

- A minimum of 3 foot clearance must be maintained in front of electrical panels at all times to permit safe operation.
- Electrical boxes must have covers in place and show no sign of damage.

2. ELECTRICAL CORDS

- Electrical cords must not be frayed, worn, abraded, corroded, or otherwise used with exposed wires or missing ground pins.
- Electrical cords must be sized appropriate to the load they are intended to carry and the environment they are exposed to.
- Extension cords are only to be used on a temporary basis and never used as a substitution for a permanent outlet.
- Multi-tap power strips are only allowed to be used with computer equipment or electronic equipment that does not draw excessive amperage per the ratings on the power strip. Power strips must be surge-protected.
- Extension cords and/or power strips must never be linked together (i.e. daisy chained).
- Do not overload electrical circuits.

3. ELECTRICAL EQUIPMENT

- Repairs and maintenance of electrical equipment must only be conducted by individuals qualified to do so by their skills in the trade, knowledge of the construction and operation of the electrical equipment, and who have received safety training on the hazards involved.
- Live parts must be effectively insulated and physically guarded.
- Electrical equipment must be kept away from wet or damp locations, unless specifically rated for use in such conditions.
- Minimize condensation that may permeate electrical equipment placed in cold rooms or refrigerators.
- Keep flammable and corrosive materials away from electrical equipment, unless the equipment was designed for such environments by the manufacturer.

E. LABORATORY INSPECTIONS

The laboratory inspection program at SJSU is a collaboration between Principal Investigators, Laboratory Personnel, the College Safety Team, and EH&S with a goal of fostering a safe laboratory work environment in accordance with federal and state regulations and University policies. To this end, laboratory inspections will be completed at a minimum of once per semester. Inspections will be completed by a team of 1 to 3 representatives from the College Safety Team and/or EH&S. Inspections will be completed using Risk and Safety Solutions' Inspect tool. Action to correct deficiencies found during the inspection must be taken within 30 days. Principal Investigators of laboratories with consistent, unresolved deficiencies will be asked to work with their Department Chair or College Dean to rectify the deficiencies.

F. LABORATORY SECURITY

Laboratory Personnel must take measures to ensure that labs remain secure to prevent theft, sabotage, or vandalism. Those working in the lab are the best defense against nefarious activity. *If you see something, say something*. Strange or odd behavior should be reported to the SJSU Police Department, the College Safety Team, or EH&S.

The following measures must be taken to ensure labs remain secure:

- Keep laboratory doors closed and locked when rooms are unoccupied.
- Ensure doors to cold rooms, dark rooms, common areas, and rooms storing hazardous chemicals are locked when unoccupied.
- Keep an inventory of all chemicals in each laboratory.
- Provide additional security, such as a locked cabinet or safe, for highly toxic or reactive chemicals.
- Dispose of hazardous chemicals that are no longer needed through the College Safety Team and EH&S.
- Do not allow laboratory access to unauthorized individuals.
- Report thefts, vandalism, or other suspicious activity to the SJSU Police Department (408-924-2222, or 911 from any campus phone) immediately.

Labs with biological select agents and toxins, radioactive isotopes, research animals, or controlled substances must comply with specific security requirements set forth by their specific governing bodies, in addition to the precautions listed above.

G. EXPOSURE MONITORING

Personal and/or environmental monitoring may be necessary when Lab Personnel exhibit signs or symptoms of a chemical exposure or when performing experiments using hazardous chemicals without adequate ventilation. Principal Investigators and Laboratory Personnel are responsible for contacting EH&S when research activities have or could lead to an actual or potential overexposure. In these cases, EH&S will perform an exposure assessment and may conduct quantitative exposure monitoring. Any monitoring results will be sent to the Principal Investigator and the affected individuals. EH&S will maintain records of all monitoring activities.

IX. WASTE MANAGEMENT AND MINIMIZATION

A. HAZARDOUS WASTE MANAGEMENT AND DISPOSAL

1. DEFINITION OF HAZARDOUS WASTE

Hazardous waste is defined by the Environmental Protection Agency (EPA) as (1) a specific list of waste chemicals or (2) as waste substances having one of the following characteristics:

- Corrosivity: pH ≤ 2 or ≥ 12.5
- Ignitability: Liquids with a flash point below 60 °C/140 °F (e.g. methanol, acetone) or is classified by the U.S. Department of Transportation as an oxidizer
- Reactivity: Unstable, explosive, or reacts violently with air or water (e.g. sodium metal), produces a toxic gas when combined with water, or contains cyanides or sulfides that can create a toxic gas or vapor
- Toxicity: Determined by toxicity testing (e.g. mercury)

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

- Abandoned chemicals
- Unwanted chemicals
- Chemicals with deteriorating containers
- Empty containers with visible residues
- Containers with conflicting labels
- Unlabeled or unknown chemicals

2. MANAGING HAZARDOUS WASTE

All hazardous wastes generated on campus must be disposed of within one year of the accumulation start date (i.e. labs may accumulate waste for 9 months then EH&S has 3 months to process and ship the waste). In general, the chain of custody, accumulation timeline, and storage requirements are as follows:

1. Laboratory starts a waste container. When the first drop of waste is added to the container, a hazardous waste tag (see Figure 4**.**) must be generated, all fields completed, accumulation start date listed, and affixed to the container.
2. Laboratory stores the waste properly while the container is being filled.
    a. Hazardous wastes must be stored according to their chemical compatibility (e.g. waste acids and bases must be segregated into separate waste streams and the containers separated from one another), stored in secondary containment, and the container must be compatible with its contents (e.g. no glass for hydrofluoric acid wastes).
    b. Waste containers must always be closed when waste is not physically being added to the container (i.e. no leaving a funnel in the open container). Waste containers must have sealable, leak-proof lids. Lids must be capable of being fully closed to prevent leakage of contents.

c. Dry wastes must be double-bagged and closed to prevent leakage of contents.

3. Hazardous waste containers must be given to the College Safety Team or EH&S within 9 months (270 days) from the accumulation start date or when the container is full, whichever comes first.
4. EH&S processes wastes and schedules a quarterly pick up and final disposal (e.g. recycling, incineration, treatment) with a licensed hazardous waste disposal company.

HAZARDOUS WASTE WORKPLACE ACCUMULATION IDENTIFICATION
SAN JOSE STATE UNIVERSITY ONE WASHINGTON SQUARE. SAN JOSE, CA 95192-0222
EPA I.D.#: CAT080031206

Container I.D. # ____________________
Person to contact re information on tag: ______________________ Phone ____________
Waste Location: Department ________________ Building __________ Room _________
Accumulation start date ______________________________

GENERAL DESCRIPTION: [ ] SOLID [ ] LIQUID pH ____
[ ] FLAMMABLE
[ ] CORROSIVE
[ ] TOXIC/POISON
[ ] OXIDIZER
[ ] EXTREMELY HAZARDOUS

CONTENTS: %

HANDLE WITH CARE!
NOTE- Hazardous Waste cannot be accumulated for more than 270 days (9 months).

Figure 5: SJSU Hazardous waste label

How to fill out a hazardous waste label:

- Write in all contents, including water, and their respective percent concentration of the total volume.
- Include the full chemical names, in English. Never use abbreviations or chemical structures.
- Check the boxes for all hazards that apply (e.g. mark "flammable" for a flammable liquid like ethanol).
- Be sure to fill in the accumulation start date.

B. UNIVERSAL WASTE MANAGEMENT

Universal wastes generated in laboratories (e.g. e-waste, batteries, light bulbs, etc.) must be recycled. Contact the College Safety Team or EH&S to dispose of laboratory-generated universal waste.

C. OTHER WASTE MANAGEMENT

1. EMPTY CONTAINERS

Empty containers that held chemicals on the Environmental Protection Agency's P-list must be disposed of as hazardous waste. These chemicals are extremely toxic (e.g. sodium azide, mercury and arsenic compounds) and their containers must not be rinsed or reused.

All other empty containers should be reused for hazardous waste collection, recycled, or discarded. The container is considered "empty" if no solids or liquids come out of the container when held upside-down nor can any further material be scraped out. The labels must be defaced (remove it or mark it out) and if reused, replaced with a label listing the new contents. If the container is to be discarded, the cap must be removed before the container can be disposed of as regular trash.

2. GLASS WASTE

Clean laboratory glass waste (broken glass, used test tubes, etc.) should be disposed of in a hard-walled laboratory glass disposal box lined with a plastic bag. The container must be taped closed at the top and bottom of the container to prevent rupture before it will be disposed of by facilities.

3. SHARPS WASTE

Syringes, glass pipettes, and other sharps contaminated with hazardous materials (> 1% of container capacity) must be disposed of in a sealable, durable rigid container labeled with a hazardous waste label. Sharps contaminated with biohazardous material must be managed as medical waste and should not be combined with chemically-contaminated sharps. Sharps containing < 1% of hazardous materials that are not odiferous may be disposed of as medical waste sharps.

4. GAS CYLINDER RETURNS

Empty or no longer needed gas cylinders must be returned to the manufacturer. Do not purchase tanks or lecture bottles that cannot be returned to the manufacturer when empty or partially used. Cylinders are considered empty when they near atmospheric pressure.

D. WASTE MINIMIZATION AND POLLUTION PREVENTION

SJSU is responsible for making efforts to reduce hazardous waste through source reduction, recycling, and other means. Source reduction includes ordering only the amount of chemical needed (e.g. not purchasing far more of a reagent than will be used because the larger volume was cheaper), retiring old equipment that contains hazardous materials (e.g. mercury), substituting less toxic or hazardous chemicals when possible, and improving work practices to reduce waste creation. Recycling includes reusing or recovering materials either on-site or offsite to reclaim value and/or reuse the material. Improved maintenance, training, and better inventory control are also effective means to minimize waste and prevent pollution.

X. EMERGENCY AND FIRST AID PROCEDURES

An emergency is an incident that poses an actual or potential threat to people or the environment. Examples include, but are not limited to, equipment failure, explosions, fire, spills, rupture of containers, or failure of control equipment that results in an uncontrolled release to the laboratory or environment. The SJSU Police Department (408-924-2222) is the designated first responder and incident coordinator in an emergency situation since they are most familiar with our campus buildings and layout. All emergencies must be reported to the Principal Investigator and EH&S (408-924-1969). In case of emergency, the following procedure should be used:

Table 7: Emergency procedure

Course of Action	
1.	**RELOCATE** everyone in the immediate work area to a safe location
2.	**ALERT –** Dial the SJSU Police Department at 408-924-2222 or 911 from a campus phone. Follow directions of the dispatcher. The person that dials SJSU police must meet them on arrival to provide further information about the emergency.
3.	**CONFINE – if it can be done safely**, close doors to confine the area where the emergency occurred. Post a “DO NOT ENTER” sign on the door(s) to prevent others from entering the space.
4.	**EVACUATE** the building through the nearest exit. Do not run or use elevators.
5.	**REPORT** to the designated meeting spot.
6.	**REENTER** only after the lab has been cleared by emergency personnel.
7.	**REPORT** the emergency incident to the Principal Investigator and EH&S (408-924-1969).

In case of significant earthquake while in the laboratory:

1. Take cover under a desk or strong door frame during the shaking. Remain under cover until the shaking subsides.
2. **If safe to do so**, shut off any gases or open flames before evacuating the laboratory.
3. Evacuate the building only once shaking has ceased. Use the stairs, do not use elevators.
4. Report any injuries or broken utility services to SJSU Police Department (408-924-2222).
5. Assist any injured individuals to receive medical attention.
6. Do not re-enter the building until it has been deemed safe to do so by the CSU building official.

A. CHEMICAL SPILLS

Chemical spills refer to the release of chemicals, wastes, oils, or other potentially dangerous materials into the air, water, or laboratory. Spills may include incidents where a person is impaired, injured, or contaminated. Chemical spills must not be cleaned up without the help of trained personnel (e.g. College Safety Team, EH&S, or emergency responders).

- For a large or extremely hazardous spill, it should be considered an emergency and the course of action in Table 7 must be followed.
- For a small/incidental spill, contact the College Safety Team or EH&S (408-924-1969) for clean-up assistance.

Never attempt to clean up a chemical spill unless you are trained to do so and have the proper materials, equipment, and support.

B. SAFETY SHOWERS AND EYEWASH STATIONS

Properly-functioning eyewash stations and safety showers are required to be available within 10 seconds travel for immediate emergency use in labs where corrosive materials are used or stored. The path of travel must be free of obstructions (e.g. doors) and the station itself cannot be blocked. Notify Facilities (408-924-1990) immediately if the safety shower or eyewash station is not functioning properly or if the shower or eyewash is not receiving monthly activations. Facilities is responsible for monthly activations of safety shower and eyewash stations.

Laboratory Personnel are responsible for identifying locations of eyewash stations, safety showers, and other emergency equipment prior to engaging in any research activities.

C. FIRST AID PROCEDURES

Some specific chemicals have very particular first aid procedures, such as hydrofluoric acid and phenol. Always consult the Safety Data Sheet for first aid response instructions before using a chemical. In general, the following procedures detail how to respond to an exposure in the laboratory:

For a hazardous chemical exposure to the eyes:

1. Move the exposed person to the eyewash station and activate the eyewash system.
2. Forcibly hold both eyes open under an emergency eyewash, ensuring an effective wash behind both eyelids.
3. Remove contacts while flushing, if worn.
4. Wash for at least 15 minutes.
5. See medical attention if needed or desired. For emergency response, dial the SJSU Police Department at 408-924-2222 or at 911 from any campus phone.
6. Report the injury to the Principal Investigator and to EH&S (408-924-1969).

For a non-hazardous chemical exposure to the eyes:

1. If the eye(s) is exposed to glass, metal, wood, or another type of particulate, do NOT flush with the emergency eyewash.
2. Cover or close the eye(s).
3. Seek medical attention, dial the SJSU Police Department at 408-924-2222 or at 911 from any campus phone.
4. Report the injury to the Principal Investigator and to EH&S (408-924-1969).

For a skin exposure to a hazardous chemical:

1. Wash the affected area with tepid water from an emergency safety shower (or sink if the site is small and localized, such as an exposure to the wrist only).
2. Remove or cut contaminated clothing while rinsing. Do not pull contaminated clothing over the head.

3. Rinse affected area for at least 15 minutes or as is indicated in the Safety Data Sheet.
4. See medical attention if needed or desired. For emergency response, dial SJSU Police Department at 408-924-2222 or at 911 from any campus phone.
5. Report the injury to the Principal Investigator and to EH&S (408-924-1969).

For inhalation of chemical vapors, fumes, or smoke:

1. If exposed person is unconscious, DO NOT ENTER THE LAB and become the next victim if the possibility of oxygen depletion, toxic vapors, or an explosive atmosphere exists. Dial 911 for emergency response (or 408-924-2222 from a non-campus phone).
2. If the exposed individual is conscious, move the person to fresh, uncontaminated air. Seek medical attention if necessary or desired.
3. Report the injury to the Principal Investigator and to EH&S (408-924-1969).

For chemical ingestion:

1. If it is safe to do so, move the affected individual to an uncontaminated area.
2. Dial 911 from a campus phone or 408-924-2222 from a non-campus phone.
3. Do not induce vomiting or drink water or other liquids unless told to do so by emergency personnel.
4. Report the injury to the Principal Investigator and to EH&S (408-924-1969).

For cryogenic liquid exposure:

1. If skin comes in contact with a cryogen, place affected area in a warm water bath (NOT above 40 °C/104 °F). Never use hot or cold water or dry heat. Thawing of the affected area must be done slowly.
2. If a burn from a cryogen occurs, do not rub the burned area. Rubbing can cause further tissue damage.
3. Seek medical attention as soon as possible for all frostbite injuries.
4. Report the injury to the Principal Investigator and to EH&S (408-924-1969).

XI. MEDICAL CONSULTATION AND MEDICAL EXAMINATIONS

Principal Investigators and Laboratory Personnel working in laboratories at SJSU must be afforded medical attention, including follow-up examinations as deemed necessary by the examining physician, under the following circumstances:

- Whenever an employee develops signs and symptoms associated with a hazardous chemical exposure;
- Where exposure monitoring reveals an exposure level above the action level (or in the absence of the action level, the permissible exposure limit) for a Cal/OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements;
- Whenever an accident such as a spill, leak, fire, explosion or other occurrence results in the likelihood of a hazardous exposure; or

- At the request of the University Chemical Hygiene Officer.

All medical examinations shall be performed by or under the direction of a licensed medical physician. Medical exams or consultations must be conducted within a reasonable timeframe from the date that the incident occurred and shall be provided without cost to the employee. Employees seeking medical attention should go to Concentra Urgent Care & Occupational Medical Center and submit an employer's report of occupational injury or illness form available on the University Personnel website.

XII. RECORDKEEPING

EH&S is responsible for maintaining records of the inspections, accident investigations, monitoring equipment calibration, and training conducted by EH&S. Departments and/or laboratories are responsible for maintaining records of health and safety trainings and laboratory inspections. Additionally, EH&S maintains records of:

- Measurements taken to monitor employee exposures
- Any medical consultation and examination records, including tests or written opinions, as required by 8 CCR 5191

A. UPDATES TO THE CHEMICAL HYGIENE PLAN

The Chemical Hygiene Plan will be updated at least annually. Before the annual update, the Chemical Hygiene Officer will solicit feedback and update requests from the College Safety Committees or College Safety Coordinator and will incorporate appropriate changes into the Chemical Hygiene Plan. The Chemical Hygiene Plan will also be updated to comply with regulatory action that changes the requirements of how hazardous chemicals are managed at SJSU.

XIII. REFERENCES AND ADDITIONAL RESOURCES

SJSU acknowledges the assistance of the University of Connecticut and UC Davis EH&S offices. The University of Connecticut and UC Davis Chemical Hygiene Plans served as a base reference for much of this content, which was adapted to the scale of research and applicability to SJSU. Special thanks to Drs. Karen Gagnon and Kelsey Mesa for the use of the Hierarchy of Controls image, Figure 3.

Supporting and cited materials are referenced electronically via hyperlink throughout the document wherever possible. The following resources also served as substantive references to this document:

American Chemical Society, Joint Board-Council Committee on Chemical Safety, Task Force for Safety Education Guidelines. *Guidelines for Chemical Laboratory Safety in Academic Institutions.* Washington DC: 2016. https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/acs-safety-guidelines-academic.pdf

National Research Council (US), Committee on Prudent Practices in the Laboratory. *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards: Updated Version.* Washington DC: National Academies Press (US): 2011. https://ucanr.edu/sites/ucehs/files/133892.pdf

XIV. APPENDICES

A. GLOSSARY/LIST OF ACRONYMS

- **Action Level:** The concentration of a specific substance which indicates certain required activities, such as exposure monitoring and medical surveillance. This value is based on an eight-hour time weighted average and is defined by Cal/OSHA.
- **College Safety Committee:** A college-level committee whose charge is to devise and implement safety policies and practices within their college. This committee often, but not always, consists of one representative member per department in the college, the College Safety Coordinator, and other safety-related individuals. This committee is not required, but it is highly encouraged.
- **College Safety Coordinator:** The individual responsible for leading the College Safety Team.
- **College Safety Team:** The team or individual designated by the College to ensure chemical and laboratory safety policies and requirements are implemented in laboratories within the College. The College Safety Team is often responsible for coordinating waste pick-ups with EH&S, scheduling laboratory inspections, and sometimes safety training.
- **Controlled Substances:** Legal or illegal pharmaceuticals that require significant regulatory oversight for their purchase and use.
- **EH&S:** San José State University's Office of Environmental Health and Safety
- **Immediately Dangerous to Life and Health (IDLH):** The concentration of airborne contaminants that is "likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment," as defined by the National Institute for Occupational Safety and Health (NIOSH).
- **Immediately Hazardous Environment:** The environment created by working with any material, activity, or circumstance that could cause an individual to become incapacitated and render them unable to seek assistance. This defines the type of work that cannot be done while alone in the laboratory.
- **Permissible Exposure Limit (PEL):** This is the limit on the concentration of a given substance in air that a worker can be exposed to over an eight-hour time weighted average (TWA), in a 15-minute short-term limit (STEL), or a ceiling (i.e. maximum exposure, C). These limits are set by Cal/OSHA.
- **Secondary Container:** A container used to store or hold chemicals that is not the original manufacturer's container. Examples include a squirt bottle, a jar, or a container. All secondary containers must be labeled with the name of the contents and the applicable hazards, if any.

- **Secondary Containment:** A device used to prevent the release of hazardous materials in the event of a spill. Secondary containment must be able to hold 110% of the volume of the largest container or 10% of the combined volume of all container contents (for multiple containers), whichever is greater. Examples include plastic bins, plastic bags, sealable storage containers, etc.
- **SJSU:** San José State University

B. REGULATIONS GOVERNING THIS DOCUMENT

1. STATE OF CALIFORNIA REGULATIONS

The necessary work practices, procedures, and policies outlined in this Chemical Hygiene Plan are required by the following State of California regulations:

- 8 CCR §3203, "Injury and Illness Prevention Program"
- 8 CCR §3380, "Personal Protective Devices"
- 8 CCR §5143, "General Requirements of Mechanical Ventilation Systems"
- 8 CCR 5154.1, "Ventilation Requirements for Laboratory-Type Hood Operations"
- 8 CCR §5164, "Storage of Hazardous Substances"
- 8 CCR §5191, "Occupational Exposure to Hazardous Chemicals in Laboratories"
- 8 CCR §5194, "Hazard Communication"
- 8 CCR Article 110, "Regulated Carcinogens"

2. FEDERAL REGULATIONS

- 29 CFR 1910.1450, "Occupational Exposure to Hazardous Chemicals in Laboratories" (also called the "Laboratory Standard"), which requires that this Chemical Hygiene Plan be readily available whenever potentially hazardous chemicals are used, handled, or stored.
- Occupational Safety and Health Act's General Duty Clause which states that employers are responsible for providing their employees work and a workplace free from recognized hazards that are likely to cause serious injuries or death, and that employees are responsible for complying with all occupational health and safety rules and regulations applicable to their own actions and conduct.

3. CALIFORNIA STATE UNIVERSITY POLICIES

- CSU Executive Order 1039: "California State University Occupational Health and Safety"

XV. REVISION HISTORY

Chemical Hygiene Plan	
Author: Alexi Ball-Jones, Ph.D.	Date: 10/17/2019
Version 1.0	Next Review: 10/17/2020
This document replaces *Occupational Exposure to Hazardous Chemicals in Laboratories* ca. 2012.	

Version	Date Published	Author	Publication Notes:
1.0	10/17/2019	Alexi Ball-Jones	New Chemical Hygiene Plan; replaces *Occupational Exposure to Hazardous Chemicals in Laboratories*, revised 2012.
2.0	10/26/2020	Alexi Ball-Jones	Added Figure 2, updated Figure 4 and hyperlinks throughout. Added links to SOP templates.