Chemical Hygiene Plan

CHEMICAL HYGIENE PLAN

SAN FRANCISCO STATE UNIVERSITY

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Complying with this CHP will keep exposures to hazardous materials below permissible exposure limits and minimize risk of injury in laboratory operations.

Environment, Health and Safety Office

Edition: November 2019
Update: July 2023
Review: July 2023

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Chemical Hygiene Plan

Overview

Following the provisions of this Chemical Hygiene & Safety Plan (CHP) is intended to protect employees from health and safety hazards associated with hazardous chemicals and keep exposures below Cal/OSHA's permissible exposure limits.

1. Required Information and Where to Find It

(A) Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals:	Chapter 2
(B) Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;	Chapter 1
(C) A requirement that fume hoods comply with Section 5154.1, that all protective equipment shall function properly and that specific measures shall be taken to ensure proper and adequate performance of such equipment;	Chapter 4
(D) Provisions for employee information and training as prescribed in subsection 5191(f);	Chapter 8
(E) The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;	Chapter 1
(F) Provisions for medical consultation and medical examinations in accordance with subsection 5191(g);	Chapter 1
(G) Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene officer and, if appropriate, establishment of a Chemical Hygiene Committee; and	Chapter 1
(H) Provisions for additional employee protection for work with particularly hazardous substances. These include "select	Chapter 6

carcinogens," reproductive toxins and substances which have a high degree of acute toxicity.

2. Labs Not Covered Under This CHP

This document does not apply to computer labs and other "labs" that do not handle hazardous materials or that do not fall on the Lab Standard's definition of "laboratory". If you are not sure whether your operation falls under this standard, please contact the COSE Health and Safety Office by email lvadura@sfsu.edu or at extension x8-6892.

3. Lab-Specific Health & Safety

This CHP describes the laboratory safety and health policies and practices established by the University that Principal Investigators, Staff and Faculty Supervisors are expected to follow.
However, since each laboratory is unique in purpose and function, the Responsible Person (PI or staff supervisor) must supply additional details to their staff on laboratory operations, such as lab rules, specific emergency actions and standard/safe operating procedures.

Responsible Person **is a faculty or staff person in charge of the work or lab space, such as Principal Investigators, stockroom and support lab managers.**

4. Laboratory Safety Organization

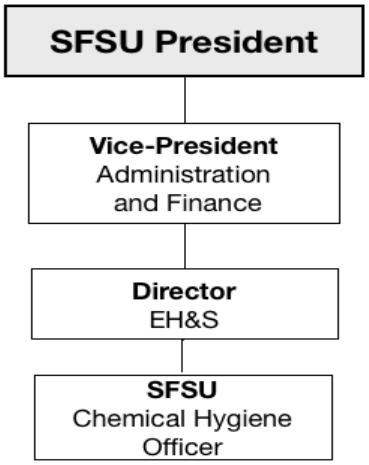
A. Chemical Hygiene Officer

A Chemical Hygiene Officer is an employee designated by the employer to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan.

Campus Chemical Hygiene Officer	**Marc Majewski, CIH**	EH&S Director
COSE Chemical Hygiene Officer	**Linda Vadura, CCHO**	EH&S Liaison to COSE

B. Organization Chart

University Administration



C. Useful Contact Information

Who To Call?

University Police (24 Hours)	**911** or 415.338.2222
Campus Environment, Health & Safety	415.338.2565
EH&S Liaison to COSE	415.338.6892

Additional Websites

SFSU EH&S	ehs.sfsu.edu
Cal/OSHA Occupational Exposure to Hazardous Chemicals in Laboratories (Laboratory Standard)	https://www.dir.ca.gov/Title8/5191.html

D. Chemical Hygiene and Safety Plan Binder

This blue CHP binder may be kept in the main laboratory or faculty/staff office and must contain the following documents:

- Lab-specific standard/safe operating procedures
- Chemical inventory (or a reference to its location)
- Lab worker training records

Chapter 1. Laboratory Standard and CHP Implementation

This chapter reviews parts of OSHA's Laboratory Standard as a basis for understanding the purpose and scope of the Chemical Hygiene Plan (CHP). Additionally, this chapter describes roles and responsibilities and how the provisions in the CHP will be implemented.

The laboratory standard was developed to address health hazards uniquid to laboratories. This Chemical Hygiene plan also covers physical safety in laboratories to better protect the health and safety of laboratory workers.

The terms "hazardous substance", "hazardous chemical", and "hazardous material" are all used in this document and, for all intents and purposes, are interchangeable. All of these terms are used depending on specific standards or regulations. The terms "acutely hazardous" (EPA) and "extremely hazardous" (Cal-EPA) are both used in this document and, for all intents and purposes, can be considered interchangeable unless otherwise specified.

1.1 Cal/OSHA Laboratory Standard

"Occupational Exposure to Hazardous Chemicals in Laboratories", often referred to as the "lab standard", was developed to address health hazards unique to laboratories. While not the only regulation that applies to laboratories, it serves as the minimum standard for laboratory safety, and requires employers to develop a written Chemical Hygiene Plan (CHP) to address the exposure issues.

Cal-OSHA Laboratory Standard, 8 CCR §5191

A. Chemical regulations that apply to laboratory operations

Cal/OSHA has the ***Airborne Contaminants Standard 8 CCR §5155*** which establishes requirements for controlling employee exposure to airborne contaminants and skin contact with those substances which are readily absorbed through the skin. Table AC-1 lists the California Permissible Exposure Limits for several hundred chemicals.

There are also chemical-specific regulations for regulated carcinogens and other toxic chemicals such as the Formaldehyde Standard 8 CCR §5217. Contact Campus EH&S at sfehs@sfsu.edu for more information, or check out the Cal/OSHA website.

The generation, storage, and disposal of hazardous waste is subject to environmental regulations. See Chapter 8 for procedures concerning hazardous waste handling.

1.2. Important Definitions

A. Cal/OSHA definition of "laboratory"

A laboratory is "a facility where the laboratory use of hazardous chemicals occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis".

B. Cal/OSHA definition of "laboratory scale"

Laboratory scale is "work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person". This definition excludes those workplaces whose function is to produce commercial quantities of materials.

C. Cal/OSHA definition of "laboratory use"

Laboratory use is "handling or using hazardous chemicals that meet all of the following conditions:

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

D. Cal/OSHA's Lab Standard definition for "hazardous chemical"?

A hazardous chemical is a "chemical for which there is statistically significant evidence, based on at least one study, conducted in accordance with established scientific principles, that acute or chronic health effects may occur in exposed employees". Chemicals with potential adverse health effects include carcinogens, sensitizers, reproductive toxins, hepatotoxins (liver), nephrotoxins (kidney), neurotoxins (CNS), and hematopoietic toxins (blood).
Health hazards are detailed in ***Appendix A of §5194 - Health Hazard Criteria***, which cites Appendix A of the federal OSHA standard in §1910.1200 (Hazard Communication).

G. Defining chemical "PHYSICAL hazards"

A chemical is a physical hazard if it is unstable at room temperature, reactive with water or air, flammable, or has some other property that can cause physical damage to persons or property.
Hazardous chemicals with physical hazards are covered under Cal/OSHA's Hazard Communication Standard (Employee Right-to-Know) and other Cal/OSHA standards

that apply to specific situations. This CHP includes information on physical hazards arising from the use of specific hazardous materials and equipment.

Different definitions of "physical hazards"

Cal/OSHA Lab Standard

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

Cal/OSHA Hazard Communication Standard

"Physical hazard" means a chemical that is classified as posing one of the following hazardous effects: explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid or gas); self-reactive; pyrophoric (liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; or in contact with water emits flammable gas. See Appendix B to §5194 -- Physical Hazard Criteria, which cites Appendix A of the federal standard, §1910.1200.

1.3 Implementing the Chemical Hygiene Plan

The San Francisco State University President is ultimately responsible for compliance with environmental and occupational safety and health regulations and has the authority to provide the practice directives and resources necessary to achieve these objectives.

A. Chemical Hygiene Plan Purpose

The Chemical Hygiene Plan (CHP) is an employer's written program that sets forth procedures, equipment, personal protective equipment, and work practices that

(1) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and

(2) meets the requirements of Cal/OSHA 8 CCR §5191(e), *Chemical Hygiene Plan*

This CHP represents the health and safety program for laboratory operations and applies to all academic departments that have laboratories as defined by the lab standard in 8 CCR 5191.

B. Workers Covered by the CHP

The CHP covers employees that handle chemicals in a manner that is "laboratory use" in OSHA defined "laboratories". Visiting scholars, research grantees, and volunteers getting academic credit are also covered by this CHP even if not technically employees.

C. Workers NOT Covered by the CHP

Ancillary operations and support staff, such as custodians and HVAC technicians are NOT covered, even if such work occasionally occurs in a laboratory. These employees are covered by other Cal/OSHA regulations such as Hazard Communication, Employer's Injury & Illness Prevention Program, and Personal Protective Equipment.

D. Responsibilities and Roles

1. Environment, Health & Safety Department

Overseeing and monitoring the implementation of these objectives is the responsibility of the campus Environment, Health and Safety department (EH&S). EH&S provides the following services, oversight, and technical assistance:

- Answers questions concerning storage, handling and disposal of hazardous chemicals.
- Oversees exposure assessments
- Inspects laboratory operations periodically and by request.
- Administers the University respirator program.
- Handles hazardous waste testing and disposal.
- Inspects and certifies fume hoods.
- Manages the On-Line Safety Training program
- Approves lab remodels and special hazardous operations

2. Chemical Hygiene Officer

The Campus Chemical Hygiene Officer (CHO) is designated by the University President to manage the laboratory safety program, usually the EH&S Director. CHOs for other administrative units may be appointed by the Campus CHO for more direct program oversight. However, the CHO is not in a supervisory role for individual laboratory operations.

The CHO does the following…

- Works with administrators to develop and implement appropriate chemical hygiene policies and practices and to develop a written CHP;
- Monitors procurement, use and disposal of chemicals;
- Helps departments ensure that quarterly self-audits are conducted, new lab workers are trained, and annual chemical inventories are submitted;
- Helps faculty develop precautions and adequate chemical storage practices;
- Maintains knowledge of current legal requirements concerning "regulated substances" and makes sure regulated substances are secured;

- Seeks ways to improve the chemical hygiene program

3. Campus Laboratory Safety Committee

This Committee meets periodically to review overall laboratory safety and compliance for the campus and includes members of SFSU administration.

4. College Deans and Administrative Unit Directors

Deans and Directors are considered "management" for the purposes of this CHP and are essential to the effectiveness of laboratory health and safety programs. They are responsible for supporting these programs, providing or arranging for resources, enforcing practice directives under their control, and for initiating disciplinary action when necessary.

5. Academic Department Chairpersons and Directors

The department Chair is considered the "manager" of their department, but it is understood that this is not an upper management role. The Chair is responsible for supporting the environmental and safety compliance efforts and assisting EH&S and operational staff in resolving issues within their departments. The campus Injury & Illness Prevention Program has additional details about the role of department heads.

6. Responsible Persons (Faculty and Staff Supervisors)

Faculty and staff supervisors are those of manage, coordinate and supervise laboratory operations and personnel. These faculty and staff members are designated as the **Responsible Person** for their laboratory operations.

The **Responsible Person** (RP) is the primary contact for his or her laboratory operations. These operations include stockrooms, academic laboratory support operations, and research laboratories. The **RP** is the manager of his or laboratory operations and, as such, has supervisory and certain administrative responsibilities that go with that role.

The table below lists the basic responsibilities of the Responsible Person and indicates what is expected of this role.

Program Area	Responsibilities and Expectations	
Administration	(a) Inventory control person is designated and communicated to EH&S (b) Chemical inventory has been updated within the past 12 months (c) Lab Health & Safety Plan (Lab HASP) is available and current (d) PROFILE in the RSS Software Suite is updated and current (e) ASSESS in the RSS Software Suite is updated and current (f) SOPs are readily available and signed off by all lab personnel	
Signs and Labels	(a) Door signs have current contact information and PPE requirements (b) Emergency procedures for the lab are posted (c) Chemical storage cabinets are labeled with current content details (d) Chemical container labels are legible, correctly identify contents, include hazard information (e) Unattended experiments are posted with information and date (f) Signs and labels meet requirements in Chapter 4 of CHP	
Inspections & Oversight	(a) Lab spaces have been inspected within the last 4 months (b) Corrective actions are complete or pending (c) PPE is worn in the lab as required and is maintained correctly (d) Hazardous materials are stored and used as required in Chapter 6 of CHP (e) All lab personnel have required documented safety training	
EH&S Training	Required General Lab Safety	Laboratory Safety Fundamentals
	Required General Lab Safety	Hazardous Waste Handling Reporting Chemical Releases
	Job-Specific	New Employee/ Lab Worker Safety Orientation
	Job-Specific	Standard Operating Procedures Review PPE requirements using RSS Assess software
	Job-Specific	HazCom: SDSs for chemicals used in the lab
Hazard-Specific Training Required When Applicable		
	Biohazards	BSL-2: Working Safely with Biohazards

	Autoclave Use	Autoclave User Training
	Laser Use	Laser Safety Orientation
	Radioactive Materials	Radiation Safety Orientation (unsealed sources) Radiation Safety Awareness (sealed sources)
	Handling Compressed Gas Cylinders	Compressed Gas Cylinder Safety
	Using Cryogens	Cryogen Safety
	Using X-ray Devices	X-ray Safety Orientation

7. Instructors and Course Coordinators of Academic Teaching Laboratories

Academic laboratories ("teaching labs") are not subject to the requirement for a lab-specific health and safety plan (Lab HASP). ***In lieu of a lab-specific HASP***, the lab manual shall include a hazard review, safety measures to be taken, and any other precautions or safety information for each assignment or experiment.

Lecturers and other instructors who teach "wet" lab classes are covered by additional safety programs such as the COSE IIPP and COSE Hazard Communication Program (HAZCOM).
Laboratory operations associated with these classes are subject to this CHP except for the lab HASP requirement.

- ***Instructors*** shall provide to enrolled students a documented initial lab safety talk and provide additional safety information and instruction as needed for new experiments.
- ***Teaching Lab Coordinators***, in charge of academic laboratories, are responsible for developing course materials that include safety and hazard information and for overseeing lab instructors.

  –Teaching Lab Coordinators are also required to provide initial health and safety training to new lab instructors and to submit the signed documents to the department office or stockroom.

8. Stockroom and Instructional or Operational Support Staff

Stockroom and support staff who prepare chemicals, mixtures, and materials for teaching laboratories are subject to the requirements of the CHP, including developing a lab or operational-specific health and safety plan.

1.4 Training and Information

The aim of training is to ensure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs. For full details on the campus EHS training requirements, see the CSU Master EHS Training Matrix for SFSU available from the EHS department.

A. Training requirements for laboratory employees

The SFSU Injury and Illness Prevention Program (IIPP) requires new employees (including student volunteer employees and temporary instructors) to receive documented initial safety training within 30 days of their work start date. All persons working in research labs must have documented training from their PI or Lab Supervisor in safe work practices, emergency procedures, and proper handling of hazardous waste.

- Tenure-track faculty and staff are required to meet with their department or administrative unit Safety Point-of-Contact for an initial safety orientation.

- Lecturers and student teachers receive their initial safety orientation from their Teaching Lab Coordinator or his/her designee.
- Part-time and temporary workers, such as student assistants, receive their initial safety orientation from their immediate supervisor or manager.

B. Frequency of refresher training

In addition to initial orientations, safety training is also required when new hazards are introduced or discovered. Some training is required annually, such as the following courses:

1. Hazardous materials handling
2. Hazardous waste labeling
3. Use of respirators (if applicable)

1.5 Records

A. Annual Evaluation of Chemical Hygiene & Safety Plan

The EH&S Director and Chemical Hygiene Officers will review the CHP each year for effectiveness and update it as needed. Significant changes will be communicated to executive management, (e.g. the Lab Safety Committee), affected faculty, staff, and departments.

B. Records each department must update and report regularly

Department Chairs and Directors are responsible for ensuring that their staff and faculty maintain training, SOP, and inspections records as required by this CHP.

- ***Hazardous materials inventory***—Faculty and staff with hazardous materials must review and verify their current chemical inventory annually submit an update to EH&S
- Annual inventory verification is due July 1 of each year
- A physical hazardous materials inventory is required at least every three years beginning with 2013.
- ***Quarterly self-inspections*** of hazardous materials rooms.
  These self-inspections are a necessary part of maintaining the University's ***Hazardous Materials Business Plan*** and SF City/County operating permit. The focus of these self-inspections is hazardous materials use and storage. For Business Plan details, contact the EH&S department.
- Principal Investigators, stockroom managers, and other lab supervisors must inspect their own work areas where hazardous materials are used or stored.

- The stockroom manager is responsible for teaching labs and the stockroom area. Principal Investigators/Faculty are responsible for their research areas, and Staff Supervisors are responsible for their areas.
  - ***List of new hires each semester***—Departments and Principal Investigators must supply the administrative unit's Safety Point of Contact a list of new hires each semester and are required to forward documented safety training to the EH&S Office. They may also provide this information directly to EH&S.
  - ***Enrolled students***—At the start of each semester, instructors are required to give a documented safety talk to students enrolled in laboratory classes that use hazardous materials. Each department track completion of this requirement/

C. Records departments must maintain and for how long

Academic departments are required to maintain the following safety-related records:

- Signed safety talk/training forms from students enrolled in "wet" laboratories. Keep for the current semester plus one year. (academic courses)

C. Records which faculty and staff supervisors must keep and for how long

Principal Investigators and Staff Managers/Supervisors are responsible for the maintaining their work spaces in compliance with regulations and campus policies.

- Record of safety training of their lab workers for the duration of their employment plus 1 year.
- A current hazardous materials inventory–*ongoing*
- Safety Data Sheets (SDS) for each material on the inventory–*ongoing*

D. Records the University is required to collect and maintain

To comply with San Francisco's Business Plan requirements, the University EH&S department collects chemical inventories from all departments that use or store hazardous materials. EH&S also maintains a master training database, air and water monitoring records, archived SDSs, quarterly self-inspections, and chemical fume hood certifications. Additional examples:

- Personal exposure and occupational medical records are available upon written request to the EH&S department.
- Respirator training, medical monitoring and fit testing per the Respirator Standard.
  - Voluntary Use signed handouts as required by the Respirator Standard.

E. WHO? verification process for keeping required records

- The EHS Director, Campus CHO and COSE CHO will review changes to the CHP annually.
- The COSE Health & Safety Office is directed to provide to the Committee documents verifying compliance activities.

- Review log to document annual CHP reviews
- Track that faculty and staff supervisors have reviewed their chemical inventory by July 1 of each year
- Track that faculty and staff supervisors review their Lab-specific Health & Safety Plans each year
- Provide inspection reports at least semi-annually.
  - Inform about any occupational exposure monitoring performed in the COSE.

1.6 Medical Program

Medical consultations and examinations are available to employees who work with hazardous chemicals, without cost or loss of pay, and at a reasonable time and place under the following circumstances:

- Whenever an employee develops signs and symptoms of possible exposure to a hazardous chemical in the laboratory;
- Where exposure monitoring reveals an exposure level above the action level (or PEL when there is no action level)
- Following a spill, leak, explosion or other occurrence resulting in a likelihood of a hazardous exposure, the affected employee must have an opportunity for a medical consultation for the purpose of determining the need for a medical examination;
- As part of the University medical surveillance program; and
- When a baseline medical exam is required by an applicable regulation or policy.

All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

Information provided to the physician and provided by the physician will be as required by Cal-OSHA's Lab Standard part(g) "Medical consultation and medical examinations".

Chapter 2. Safety Principles & Basic Lab Rules

2.1 Principles of Hazard Control

This chapter reviews the principles of creating a laboratory environment that minimizes exposure to chemicals and where the risk of injury and illness is controlled. Taking the time to plan a project and assess the hazards involved is a basic principle of safety. Without this step, it is difficult to effectively minimize the risks of those hazards.

Consider the hierarchy of safety controls below when planning a new lab or project.

A. Hierarchy of Controls

There is a hierarchy of safety controls to be employed to minimize workplace hazards

- (First) Engineering Controls
  - Eliminating a process or material
  - Substituting a less hazardous material or process
  - Enclosing a hazard
  - Automatic safety interlock controls
  - Ventilation or local exhaust
- (Second) Administrative or Management Controls
  - Job Hazard Analysis (JHA)
  - Standard/Safe Operating Procedures
  - Warning signs and labels
  - Training
  - Limit exposure time
- (Last) Personal Protective Equipment

  Considered the last line of defense, personal protective equipment or PPE depends on the lab worker to choose and wear the items properly so they can be effective.
  - Gloves
  - Safety glasses or splash goggles
  - Face shield
  - Lab coat

- Chemical-resistant apron

Use the above information on hierarchy of controls as a guide when evaluating your laboratory environment, tasks and projects for safety and health risks.

B. Planning Ahead

Before starting a new experiment or research project, think about the chemicals and equipment you will need and what could go wrong.

1. Facility Needs

An important but often overlooked factor is facility needs. Do you need a 220V outlet? More power outlets? Additional circuits installed for equipment that cycles or draws significant power? For very heavy equipment, such as seawater tanks, can the floor handle the weight?

In some cases, work cannot begin until structural or remodeling work is completed.

Are any of the following equipment or upgrades required for the project?

- Chemical fume hood
- Biosafety cabinet
- Sink for hand washing
- Safety shower and/or eye wash station
- Extra secure door lock
- Windows that require screens
- Electrical outlets for wet environments
- Refrigerator/freezer to store flammables

Actions

1. Use a checklist to evaluate the space you were given.
2. Talk to the people in charge of allocating laboratory space if the space provided isn't suitable for the intended work.

2. Protocol Review

Review the protocol you intend to use. Do some research. Is it the most current available?

1. Are there alternatives to some of the steps that are safer but still provide the desired results?
2. Can you substitute a less hazardous chemical?
3. Are there any steps you can eliminate to reduce the hazard?
4. Do you have access to the appropriate facilities and equipment?

Actions

1. Evaluate your protocol for safety and the quality of prospective results.
2. Modify the protocol as needed to minimize the inherent hazards while still producing the desired outcomes.

C. Job Hazard Analysis

A Job Hazard Analysis (JHA) is a tool to assess potential hazards of the tasks workers perform which is then used to develop a Safe or Standard Operating Procedure (SOP) to address safety issues identified during this process. The format is widely used and is intended to help you organize your thoughts.

Figure 2.1 Sample JHA

List Tasks and Equipment	List all the things that COULD go wrong—not just what is likely to go wrong.	List the things you could implement that would minimize the risk of someone being hurt.
Using a bunsen burner	Burns; hair could catch fire; flammable materials nearby could ignite; the solution being heated could react violently; material could boil and spill; clothing or notes could catch fire	Specifying which solutions or liquids may be heated using the bunsen burner; substituting another heating method; tying back hair and securing long sleeves; clearing paper and flammable materials from work area; specifying the preparation of the solution carefully so it won't react badly when heated.

Actions

1. Perform a Job Hazard Analysis on a couple tasks or procedures to familiarize yourself with this process.
2. Use the resulting JHA as a training tool and to write or revise an SOP for the task(s).

D. Standard or Safe Operating Procedure

Standard or Safe Operating Procedures (SOP) are different names for describing how the work should be done and in a safe manner. A Safe Operating Procedure is the written procedure for using equipment, performing certain tasks and starting up or shutting down equipment that includes safety information.

The level of detail in an SOP is up to the Responsible Person (RP), unless EH&S has designated a mandatory version. Written procedures or practices may be posted near an operation, accessible in a file or binder, or available on a computer and should include the following information:

- Type of hazard such as hot surfaces, skin absorbing chemicals, flammability;
- Precautions such as protective equipment, power shut off, handling technique;
- List of steps along with safeguards;
- Cautionary information like special hazards to watch out for.

SOPs for some common tasks, equipment and materials used in laboratories are available in *Chapter 3.*

Actions

1. Review the SOPs used in your lab periodically for accuracy.
2. Train laboratory personnel using the SOPs.
3. For tasks or procedures that pose a high risk, the SOPs should be signed off by all lab members expected to perform them.

2.2 Understanding Risk and "What is Safe"

An item or procedure designated as 'safe' could better be described as one with 'acceptable risk'. Nothing one can do is truly without any risk. What is acceptable to one person may not be acceptable to another.

"Hazard" is an inherent quality of a material or situation.

"Risk" is based on one's exposure to a hazard.

The ***perception of risk*** is an important consideration, as it may have little to do with ***actual risk***.

People often get hurt because there is lack of understanding of hazards and potential risks. Communication of both the hazards of an operation or material and the necessary precautions (via SOPs) is critical to preventing accidents. The Job Hazard Analysis process can be a very useful tool and the Responsible Person (RP) is strongly encouraged to use it.

An example of a situation where the hazards of a process or procedure need careful evaluation is when experiments are scaled up. Are the inherent hazards of increasing the quantity used commensurate with the benefits of doing so?

A. Scaling Up Experiments

Keep in mind the intrinsic properties of a chemical or equipment operation when planning your experiment and writing the SOPs. When scaling up an experiment, be aware of what can happen when the quantity is increased. The consequences are more serious when larger quantities of chemicals unexpectedly mix.

Actions

1. Evaluate what can happen when scaling up a process.
    - Larger or heavier containers

- Longer tubing
- Increased friction
- More material than can burn or react
- More powerful equipment or increased electrical hazards

2. Update SOPs and have laboratory personnel sign off on the changes.

2.3 Pregnancy

By using prudent work practices, most laboratory workers who are pregnant or planning pregnancy can work safely in research laboratories without exposing the fetus to potentially harmful chemicals.

Handling reproductive toxins and skin absorbing chemicals should be limited as much as possible.

Women who are pregnant are not prohibited from working in the laboratory, but they should exercise caution:

- Use protective equipment and fume hoods diligently
- Wash hands frequently
- Read the relevant Safety Data Sheets (SDS) for the chemicals in their laboratory
- Review the hazards of the chemicals with their lab's Responsible Person to determine whether any of the materials used pose additional risk during pregnancy.

Pregnant women should carefully discuss their job activities with their personal physician or medical services provider. It is up to each person to decide for themselves. Below are links to online information that may help with this decision.

ATSDR Toxic Substances Portal - Info. Search

NIOSH Publication 99-104 on Workplace Hazards and Pregnancy

2.4 Basic Laboratory Safety Rules

The basic safety rules (or Standard/Safe Operating Procedures) for laboratory work at SFSU are described in this section. Individual departments and laboratories may have more extensive rules and specific standard work practices but must be at least as stringent as the basic laboratory safety rules described in this CHP.

General Safe Operating Procedures for operating ***laboratory equipment and materials*** are available in *Chapter 3.*

General Safe Operating Procedures for ***receiving, storing and using hazardous materials*** are discussed in detail in *Chapter 6.*

A. Hygiene and Housekeeping

1. No eating, drinking, gum chewing, putting on makeup, or adjusting contact lenses are permitted in labs with hazardous materials.
2. Wash hands before leaving the lab and after chemical contact.
3. Keep aisles and doorways clear. Do not block emergency equipment.
4. Clean bench tops and tidy up when work is finished.
5. Clean up spills promptly and wipe up spillage on containers.
6. Store heavier chemical containers and corrosives on lower shelves.
7. Store chemical containers on shelves or cabinets by hazard category.
8. All chemical containers must be labeled or have an identifying mark corresponding to a lab notebook entry, posting, or notice.
9. Warning signs, emergency contact information, and cabinet labels must be current.
10. Store respirators and other re-useable PPE in a bag or drawer to prevent contamination.

B. Work Practices

1. Do not force glass tubing into rubber stoppers.
   Lubricate the glass and hold the tubing with a cloth towel as you insert the tubing into the stopper.
2. Use a bulb or other device for suction. Pipetting by mouth is unsafe and not allowed.
3. Never taste chemicals. Do not "waft" to test chemical odors unless specifically directed to do so in the experimental procedure – and only with extreme caution.
4. Avoid burns by checking if an object is hot before handling or touching.
5. Only perform authorized experiments. Do not deviate from the SOP without prior approval from the lab Responsible Person.
6. Check that the fume hood is working before using it to handle hazardous materials.
7. Ensure personnel who wear dust masks and other respirators are enrolled in the campus respirator program or have a signed **volunteer use form** on file with EH&S.

C. Lab Apparel

Dress appropriately for work in laboratory areas with hazardous materials. Minimum below:

1. Avoid loose or baggy clothing and dangling jewelry. Roll up long sleeves when working around open flames or moving equipment. Confine or tie back long hair.
2. Wear lab coat. It must fit and be buttoned up.
3. Wear enclosed shoes. No open toe shoes or sandals are permitted.
4. Wear long pants or skirt so that legs are covered.
5. Wear wrap-around safety glasses or splash goggles when in the lab.

D. Security and Access

1. Limit access to visitors, especially minors, to hazardous laboratory areas.
   When work is being performed, everyone must be wearing appropriate PPE and be authorized to be there by the lab Responsible Person.
2. Register visiting scholars and volunteer students as official "Volunteer Employees".
   Provide the same training and protective equipment as other lab employees.
3. Keep labs locked when unoccupied.
4. Do not work alone when performing hazardous tasks or procedures.
5. Do not leave reactions or experiments unattended. If it is necessary to run an experiment overnight or longer, post unattended experiments with information about what is going on, contact person(s), and dates.

   Link to a sample Unattended Experiment Form will be available soon.

2.5 Work Conditions and Behavior

Because of the hazards inherent in laboratories, people are expected to behave in an adult professional manner with respect for the risks. Lab workers should expect fume hoods and emergency equipment to be properly maintained and functional.

1. Put an "out of order" sign on damaged equipment. Do not let it be used.
   Do not make electrical repairs. Do not "jury rig" equipment to get it to work.
2. Check eye wash stations to be sure there is water flow and fire extinguishers to be sure the pressure indicator is in the 'green' before starting hazardous lab work.
3. Report equipment problems and building issues, such as leaks and broken tiles to the Responsible Person (RP).

The RP must report building problems to stockroom or operations staff so they can submit a work order to Facilities for repairs.

A. Personal Behavior in the Lab

Demonstrating prudent and professional behavior within the laboratory is a critical part of a culture of safety. You can enjoy your work, but the laboratory environment is not conducive to physical play.

Prudent behavior includes following basic safety rules and policies, being cognizant of the hazards within the laboratory, exhibiting professionalism with co-workers, and maintaining an awareness of the work being performed in nearby hoods and on neighboring benches, and any risks posed to others by you.

If you are exhausted, sleepy, taking cold medicine, or other medications or substances that impair your ability to work safely– STOP. Don't perform any hazardous tasks if you are sick or otherwise impaired. Ask for help if the work or task is critical.

B. Working Alone

Avoid working alone with hazardous chemicals or equipment. Someone must be within sight or earshot and be aware of the hazardous work being done.

If an accident or other emergency occurs, having another person available to get help could be critical to preventing harm or minimizing serious injury. Using the "Buddy System" is strongly encouraged. Refer to the Campus Directive, if available, and discuss with Department Chair if there is a conflict.

When it is absolutely necessary for someone to work by themselves, the Responsible Person (RP) is responsible for all documentation and communication of a policy for his/her lab.

After-Hours Work

All work in laboratories with hazardous materials or equipment must be authorized by the Principal Investigator (Responsible Person) or Department Chair. Documentation of this authorization is the responsibility of the RP.

2.6 Personal Protective Equipment

Using personal protective equipment (PPE) is the last line of defense when engineering and administrative controls aren't sufficient to reduce the hazard to an acceptable level.

See the campus ***Personal Protective Equipment Program*** for full details on how the use of PPE is implemented at SFSU.

A. General SOP: Using Personal Protective Equipment

1. Choose the right equipment for the hazard. Make sure it fits.
2. Inspect PPE before using it. Check for holes or other damage.
3. Wear PPE as required. It's not effective if it's still in the box.
4. Replace damaged, contaminated, or dirty PPE.
5. Do not reuse disposable PPE.
6. Clean reusable PPE carefully. Rinse well to avoid skin irritation later.
7. Store PPE in a clean plastic bag, cabinet, or drawer to prevent contamination.

B. Responsibility for PPE

The **Responsible Person** (PI or Staff Supervisor) is responsible for: ensuring that the correct PPE for the tasks in their labs is available; training their lab workers in the correct use and storage of required PPE; and for enforcing the use of required PPE.

Individuals are responsible for wearing their PPE as directed, keeping it clean, and changing it out when damaged or contaminated.

EH&S is responsible for maintaining a compliant PPE program and auditing labs. EH&S staff is available to provide guidance in choosing appropriate PPE. Tools such as ASSESS software and PPE Hazard Assessment guides can help with identifying the correct PPE to use.

Only NIOSH approved respirators will be provided to employees.

C. Dust Masks for Comfort Use—Voluntary Use

Dust masks are a type of respirator, called a "filtering facepiece". While filtering facepiece respirators do filter out particulates, they do not filter out gases or vapors.

Dust masks must not be used as protection from air contaminants present at concentrations greater than permissible exposure limits (PELs).

For particularly dusty tasks or low levels of mold or aerosols, dust masks may be issued by the stockroom manager or Responsible Person (RP) on a volunteer basis for "comfort use" only.

To obtain one, an employee must complete a mandatory "***Volunteer Respiratory Use Acknowledgment***" form, which includes the reason for the request, comfort use only statement, and instructions for basic training and care. The stockroom manager may consult with the EH&S staff prior to issuing a dust mask if there are any concerns.

The signed ***"Volunteer Respiratory Use Acknowledgment"*** form must be sent to EH&S and be on file for each "dust mask" wearer using it voluntarily for non-hazardous work. The form stays on file in the EH&S office for the duration of employment in the same job or work area.

Personal Facemasks and Respirators

Students and visitors who bring their own facemasks or respirators to campus for personal reasons may wear them because they are not covered under the campus Respirator Program. Employees who want to wear their own facemasks or respirators for personal reasons are urged fill out the ***"Volunteer Respiratory Use Acknowledgment"*** form to document that the wearer has seen the information on the form. Facemasks that are not NIOSH approved, such as surgical masks, are not considered respirators. See Note 2 in section D.

D. Respirators for Hazardous Air Contaminant Protection

Respirators are rarely used in laboratories because of the relatively low quantities of chemicals used at a time and because fume hoods and other lab ventilation provide the primary exposure protection.

Cal/OSHA's Respiratory Protection Standard has strict rules governing respirators including requirements for medical surveillance, hazard assessment, fit testing, and employee training

If respirators are required to protect personnel from hazardous air contaminants, then all provisions of the campus Respirator Program will be implemented. EH&S staff must assess the potential for overexposure to an air contaminant in the work area before an appropriate respirator may be issued to an employee. The wearer must also pass a medical evaluation and fit test. Contact Campus EH&S for details about the respirator program or for a hazard assessment.

N95 Respirators for Non-Voluntary Use

An N95 rated dust mask respirator (also called a filtering facepiece respirator) is suitable for non-hazardous levels of aerosols and particulates, such as dusts, powders, and mists. Another use for N95 respirators is to protect against biohazardous particulates and aerosol transmissible diseases. N Series is a class of respirators with N95 filters that can remove at least 95 percent of very small (0.3 micron) airborne particles.

When N95 respirators are ***required*** for protection as a result of a hazard assessment, this use is no longer 'voluntary' and is subject to campus respirator protection program requirements.

Note 1: A surgical **N95** respirator is a NIOSH-approved N95 respirator that has also been cleared by the US Food and Drug Administration (FDA) as a surgical mask for use in healthcare settings.

Note 2: A **facemask** is a loose-fitting disposable device that creates a physical barrier between the mouth and nose of the wearer and large-particle droplets or splashes. Facemasks can also help reduce others' exposure to your saliva and respiratory secretions. These are NOT respirators, are not NIOSH approved and are not suitable for protection against hazardous or infectious aerosols or particulates.

Chapter 3. Safety–Space and Equipment in Labs

Chemical exposures and associated health hazards aren't the only safety risks in laboratory work. The inherent hazards of laboratory spaces and equipment are known to cause injuries and expensive property damage.

The chapter reviews the hazards and safe work practices for common laboratory equipment, materials and spaces.

Lab workers can get injured from misusing equipment or when such equipment fails. See the examples below:

1. Electrical shocks from older electrophoresis equipment.
2. Shrapnel and hazardous chemical exposure from exploding equipment when high heat or pressure ruptures containment.
3. Burns from escaping steam, hot liquids, flames, or hot surfaces.
4. Cuts and punctures from broken glass, pipettes, scalpels, or needles improperly handled or not inspected before use.
5. Sudden release of pressure from compressed gases. For example, a gas cylinder can turn into a missile if the valve breaks off.

Actions

1. Inspect lab equipment periodically to make sure it is in good working order.
2. Review the general SOPs in this chapter with laboratory personnel.
3. For equipment or materials that pose a high risk, evaluate equipment-specific SOPs and update as needed.
4. Have all lab members sign-off on the SOPs to show they understand what is expected .

Complying with Standard/Safe Operating Procedures (SOPs) for common conditions or equipment in laboratories reduces the risk of injuries.

3.1 Clutter and Disorganization in the Lab

Poor housekeeping makes it hard to do good science. Poor labeling and inventory management, difficulty in finding what you need, contaminated containers, messy lab notebooks, and tripping over things all contribute to making mistakes and causing injuries.

A strong correlation exists between orderliness and the level of safety in the laboratory. Chemicals and equipment stored on the floor in walkways and blocked eye washes or showers are examples of poor housekeeping that increase injury risk.

- A disorderly laboratory can hinder or endanger emergency response personnel, Facilities technicians, custodians, and other ancillary staff.
- Slip, trip, and fall hazards are common sources of workplace injuries.

General SOP: Housekeeping in Labs

1. Never obstruct access to exits and emergency equipment such as fire extinguishers and safety showers.
2. Store coats, bags, and other personal items in the proper area, not on the benchtops or in the aisles.
3. Keep chemical containers closed when not in use
4. Do not use floors, stairways, and hallways as storage areas. Items stored in these areas can become hazards in the event of an emergency.
5. To reduce the chance of accidentally knocking containers to the floor, keep bottles, beakers, flasks, and the like at least 2 inches from the edge of benchtops.
6. Keep drawers and cabinets closed when not in use, to prevent people from bumping into them.
7. Wipe residues from container exteriors and clean up spills promptly.

3.2 Sharp Objects and Broken Glass

Cuts and punctures from handling sharp objects are one of the most common causes of laboratory injuries. Leather and mesh cut-resistant gloves are available, but they are not very effective against punctures. Puncture-resistant gloves used by security and police personnel exist but not commonly used in laboratories because of dexterity and contamination issues.

General SOP: Sharp Objects and Broken Glass

1. Discard cracked or chipped glassware promptly.
2. Wash, handle and store laboratory glassware with care to avoid breakage.
3. Do not pile up dirty glassware in the sink, as dirty water can mask glassware fragments.
4. Use tongs or brush/dust pan to remove or clean up broken glass and other sharps.
5. Dispose of broken glass in a specially labeled container for broken glass. If one is not available, broken uncontaminated glassware can be discarded in a sturdy cardboard or plastic box, taped closed, and labeled as "broken glass".
6. Treat broken glassware contaminated with a hazardous substance as a hazardous waste.
7. Dispose needles, razor blades and other sharps in a specially labeled container for sharps that meets the CA Medical Waste Management Act criteria.

   Sharps used in chemistry analytics and only contaminated with chemicals should be disposed of in an EH&S-approved sharps containers for worker safety and MUST be labeled and disposed of as chemical hazardous waste. Use non-red sharps containers to collect this type of waste.

3.3 Electricity

In the laboratory, workers may be exposed to electrical hazards including electric shock, arc blasts, electrocutions, fires and explosions. Potential exposures to electrical hazards can result from faulty electrical equipment/instrumentation or wiring, damage receptacles and connectors, or unsafe work practices.

General SOP: Electrical Equipment

1. Do not use electrical equipment to perform a task for which it is not designed. Wet or corrosive conditions or areas where flammable vapors may build up may need specialized equipment or electrical connections.
2. Insert 3-pronged plugs into 3-pronged power outlets to have a connection to ground for protection from electric shock. Do not insert a 3-prong plug into a 2-prong outlet.
3. If you plug more than two pieces of low demand equipment into a standard outlet, use a power strip with a circuit interrupter that will shut off if too much power is used. This is a fire safety feature required by fire and electrical codes.
4. Make sure that any outlet near a sink or other water source is Ground-Fault Circuit Interrupter (GFCI) protected.
5. If you have a GFCI, periodically test it by plugging something into it and pushing the "test" button. Once the equipment shuts off just turn it back on.
6. Do not disable any electrical safety feature, such as interlocks, GFCIs and guards.
7. Before turning equipment on, check that all power cords are in good condition.
8. Do not use extension cords as a substitute for permanent wiring—violates fire code.
9. Verify your power needs with Facility Electricians. Equipment that draws a lot of power or that cycles off and on may need a separate circuit.
10. **If you see a person being electrocuted, DO NOT TOUCH THEM!** The electricity can go through you, too. If possible, turn off the power (pull the plug or trip the circuit breaker), or use an item made of non-conductive material (e.g. wooden broom handle) to pry him or her away from the contact. Call 911 immediately!

3.4 Moving Parts and Kinetic Energy

Equipment with moving parts and springs can cause serious injury. Although moving parts in equipment are usually associated with industrial, agricultural, or machine shop-type operations, some laboratory equipment does have moving parts to watch out for. For example, vacuum pumps have moving parts are covered by a guard to prevent fingers, hair, sleeves, etc. from accidentally getting caught.

General SOP: Moving Parts and Kinetic Energy

1. Do not put fingers or other body parts into equipment while it is operating if not designed for this purpose.
2. Unplug equipment before doing maintenance or pulling out stuck objects.
3. Check that interlocks and guards are in place and working.
4. Check that machine is stable and has a balanced load.
5. Safely release stored energy before dismantling equipment for maintenance or disposal.

The RULE

Never remove or defeat the guards or interlocks on equipment that is powered "on". This is a standard prohibition when using lasers, x-ray or μv generating equipment, as well as centrifuges and other equipment with moving parts.

3.5 Extremely Cold Substances and Materials

Cryogenic liquids are extremely cold liquids that at normal temperature and pressure would be a gas, such as liquid nitrogen (LN2). Although not a cryogen, solid carbon dioxide (dry ice) which converts directly to carbon dioxide gas at -78°C (-109°F) is also often used in laboratories and has similar hazards.

Oxygen Deficiency: Cryogenic liquids can create an oxygen deficient environment because of their large liquid-to-gas volume displacement ratios, typically about 700:1.
One liter of liquid nitrogen can expand to over 700 L of gas quickly which can be dangerous in a small lab space.

Cold Burns and Adhesion: Cryogens and dry ice can cause cold burns and frost bite to unprotected skin. In addition, the cold surface of equipment and piping containing cryogenic liquid can cause the skin to stick to the surface and can tear as you attempt to remove it.

Co-condensing liquid oxygen: Liquid O2 that is co-condensed from liquid N2 is an extremely reactive and exothermic.

General SOP: Handling Cryogens or Dry Ice

Before starting to use, transfer, or transport cryogens, make sure you are wearing safety goggles and a face shield, gloves, and have the right container to transfer or transport.

1. Avoid eye or skin contact with these substances.
2. Never handle dry ice or liquid nitrogen (LN2) with bare hands.
3. Use cryogenic gloves, which are designed specifically for working in freezers below -80°C and for handling containers or vials stored in these freezers.
4. Cryogenic gloves need to be loose-fitting so that they can be readily removed if liquid nitrogen (LN2) splashes into them or a piece of dry ice falls into them.
5. Always use appropriate eye protection.
6. Do not use or store dry ice or LN2 in confined areas, walk-in refrigerators, environmental chambers or rooms without ventilation. A leak in such an area could cause an oxygen-deficient atmosphere.
7. Never place a cryogen on tile or laminated counters because the adhesive will be destroyed.
8. Make sure sinks and counters are compatible with cryogens before allowing disposal or contact with these surfaces. Sinks can crack.
9. Never store a cryogen in a sealed, airtight container at a temperature above the boiling point of the cryogen; the pressure resulting from the production of gaseous

carbon dioxide or nitrogen may lead to an explosion.
Most regulators used with LN2 have a pressure relief valve to prevent this from happening.

3.6 Compressed Gases

Compressed gas cylinders can be extremely hazardous if mishandled. The contents in a cylinder are under pressure and many compressed gases are hazardous. Hazards include

- mixing of incompatible gases;
- asphyxiation;
- release of toxic gases
- explosion from leaking valves; and
- sudden release of pressure (the torpedo effect)
- heavy cylinder falling onto a handler's foot

A. General SOP: Using and Handling Compressed Gas Cylinders

Protect the cylinder valve. Most of the handling rules are designed to prevent the valve from leaking or breaking. ***Do not leave unsecured gas cylinders unattended.***

1. Screw the cap all the way down to the neck ring before moving it.
2. To move a gas cylinder use a cylinder cart and secure it to the cart.
3. Secure gas cylinders to the wall or heavy furniture or equipment before using. Two secure points are required. Roughly at the top and bottom thirds of the cylinder.
4. Use the right regulator for the gas in the cylinder.
   Regulators are not interchangeable with different gases.
   - Check the regulator before attaching it to a cylinder. If the connections do not fit together readily, a wrong or inadequate regulator is being used.
   - Make sure the materials in the regulator are compatible.
   - Attach the regulator securely before opening the valve.
   - Stand to the side of the regulator when opening the cylinder valve.
5. Open cylinder valves SLOWLY.
   - Do not use a wrench to open or close a hand wheel type cylinder valve.
   - If the valve cannot be operated by hand, contact the vendor to repair the valve.

B. General SOP: Storing Compressed Gas Cylinders

A gas cylinder is considered "stored" when it will not be used for any purpose. Set ups in classrooms and active research labs where the gas will be used occasionally throughout the semester will be considered "in-use".

Store cylinders upright in a well-ventilated area away from open flames, sparks or electrical circuits and any source of heat or ignition. Never store cylinders at temperature above 130° F.

1. If not currently "in use", disassemble set-ups on gas cylinders and place them in storage until they are needed again.
2. Do not store gas cylinders with regulators attached, replace safety caps.
3. Separate full and empty cylinders of all gases and identify the storage areas by signs to prevent confusion.
4. Store oxygen and nitrous oxide cylinders (empty or full) away from flammable or fuel-gas cylinders and combustible materials by a minimum distance of 20 feet or by a barrier at least 5 feet high having a fire-resistance rating of at least one-half hour

3.7 Centrifuge

Unbalanced centrifuge rotors can result in injury or death. Broken sample containers can release aerosols that are harmful if inhaled. OSHA reports that the majority of centrifuge accidents result from user error. It is important to review the manufacturer's operating instructions. Exposure to hazardous biological and chemical aerosols can result from unsealed rotors.

General SOP: Using Centrifuges

1. Ensure that centrifuge bowls and tubes are dry.
2. Ensure that the spindle is clean.
3. Use matched sets of tubes, buckets and other equipment.
4. Always use safety centrifuge cups to contain potential spills and prevent aerosols.
5. Inspect tubes or containers for cracks or flaws before using them.
6. Avoid overfilling tubes or other containers (e.g., in fixed angle rotors, centrifugal force may drive the solution up the side of the tube or container wall).
7. Ensure that the rotor is properly seated on the drive shaft.
8. Make sure that tubes or containers are properly balanced in the rotor.
9. Apply vacuum grease in according to the manufacturer's guidelines.
10. Do not exceed the rotor's maximum run speed.
11. Close the centrifuge lid during operation.
12. Make sure that the rotor has come to a complete stop before opening the lid.*

Centrifuging Infectious Materials

Purchase units with sealed rotors or other aerosol limiting devices when centrifuging infectious materials or put entire unit into a biosafety cabinet.

*When centrifuging infectious materials, *wait 10 minutes** after the rotor comes to a complete stop before opening the lid.

3.8 Hot Plates and Stirrers

Purchase hot plates and stirrers suitable for the application and environment in which it will be used. Use equipment rated for use with flammables or in potentially explosive atmospheres.

Use only spark-free induction motors in power stirring and mixing devices. Even if so equipped, their on-off switches and rheostat-type speed controls can produce an electrical spark because they have exposed electrical conductors.

Consider the consequences of stirrer failure, electrical overload or blockage of the motion of the stirring impeller. Stirring and mixing devices, especially stirring motors and magnetic stirrers, are often operated for fairly long periods without constant attention.

Only use hot plates that have been approved by a Nationally Recognized Testing Laboratory (NRTL) such as Underwriter's Laboratory (UL).

A. General SOP: Using Hot Plates

1. Always turn off hot plates when not in use. The hot plate main power switch should be turned off in addition to the heater power switch.
2. Use heat resistant containers such as borosilicate glassware on hot plates. DO NOT use plastic containers as these can melt. Always inspect glassware for cracks or other damage prior to use.
3. Always use a hot plate that is larger than the container being heated.
4. Use thermal gloves or tongs when removing hot items from a hot plate. If possible, allow items to cool prior to handling.
5. Ensure that electrical cords and temperature sensor probe wires do not come in contact with the hot plate surface.
6. Periodically test the function of the "off switch" to verify it works and the hot plate quickly cools. Units that fail should be immediately taken out of service.
7. Before using, check hot plates for damage such as chipping or etching. Also check for damaged electrical cords. Damaged units must be immediately taken out of service.
8. Avoid unattended use of hot plates. If unattended heating cannot be avoided, consider the use of an additional feedback system such as pre-set timers or automatic high temperature shut-off.

- Post a sign indicating that an experiment is in progress, with date and experimenter contact information, to show that the hot plate was not left on by accident.

9. Do not use the high temperature setting to heat low boiling point liquids. Allow liquids to heat gradually on low or medium settings. If it is necessary to boil a solvent, use a condenser rather than an open beaker or flask.
10. Do not use power strips inside the fume hood to power hot plates. Use the outlets provided outside of the hood.

B. General SOP: Hot Plates and Flammables

1. Do not store combustible materials or flammable liquids near hot plates. This includes squeeze bottles that can drip. Minimize quantities of these materials inside the fume hood and segregate through the use of trays.
2. Provide secondary containment for any flammable liquids being heated to prevent liquid from contacting the hot plate in the event of a leak or overflow.
3. When heating flammable materials is necessary, only use hot plates designed for such use. They will be labeled as explosion proof or intrinsically safe.

C. Special Hot Plate Considerations

1. Do not heat strong oxidizing materials in oil baths. A reaction could occur in the event of a leak or overflow.
2. On some models the temperature dial can be rotated from “low” to “off” and then to “high” while rotating in the same direction. A researcher could rotate the dial past the “off” position to the “high” position causing an overheating condition. Consider replacing these units.
3. Older non-digital hot plates should be provided with a “power-on” indicator light and a temperature control knob which stops at a clearly marked “off” position.
4. Take out of service hot plates that are damaged or don’t work properly. Consider replacing older units without working safety features.

3.9 Refrigerators and Freezers

Before purchasing a new refrigerator/freezer, or using an existing one, consider whether chemicals will be stored in this unit. Note that many lab refrigerators will be around for decades and therefore one cannot guarantee that a normal unit will never be used for flammables storage. There are two types of refrigerator/freezer models that should be considered, depending on the type of hazardous material the unit will store.

A. General SOP for Refrigerators and Freezers

1. Place a label on the door indicating that no food or beverages may be stored inside.
2. Maintain a clean and organized interior.
   - Every item inside must be labeled, identifying it and who it belongs to, including experimental vessels or containers.
   - Containers must be wiped clean and be in good condition.
   - Clean up spills promptly. There should be no spilled material observed upon inspection.
3. All refrigerators or freezers intended to store flammable materials MUST be approved refrigerator/freezer units. Approved units are marked by the manufacturer as "for flammable storage" or "explosion-proof", depending on the unit.
4. Take out of service those refrigerators and freezers that are not "approved" as indicated but are being used to store flammable or explosive materials. Relocate chemicals as soon as possible until a replacement refrigerator/freezer is installed.
5. Supervisors are required to replace refrigerators and freezers that are not approved for the storage of flammables—if they are being used to store flammables.

   Don't store flammable liquids or solids in refrigerators that are not clearly labeled "EXPLOSION-PROOF" or "FLAMMABLE SAFE" or equivalent.

B. Household Refrigerators and Freezers in the Lab

Avoid purchasing household refrigerators or freezers for laboratory use. While more expensive, units designed for laboratories are more robust and should do a better job of maintaining a constant temperature. For storing chemicals, purchase a unit designed for this purpose. For example, the light switch, defrost feature, and thermostat inside the storage compartment have been removed, upgraded or relocated.

C. Storage of Flammables

Certain refrigerator/freezer units are designed specifically for the storage of flammable materials to prevent fires or explosions inside the unit. These units have special protections to prevent ignition of flammable vapors.

Flammable storage units have no internal electrical components that could trigger an explosion inside the unit. These must always be used for storage of volatile materials.

D. Explosion-Proof for Hazardous Environments

Explosion-proof units prevent triggering of interior or exterior explosions in a hazardous environment. Every motor and thermostat are designed to prevent arcing and possible ignition and are usually hard-wired. Used for storage of volatile materials in areas with explosive atmospheres. These are rarely necessary in standard lab environments. *In areas with explosive atmospheres, the room electronics, etc., should be explosion-proof as well.*

3.10 Vacuum Lines

Vacuum lines may become contaminated with chemicals or pathogens.

General SOP: Vacuum Systems

1. When using house vacuum systems with bacteria, viruses, etc., the attached hose must be equipped with an inline filter to prevent contamination of the vacuum pump oil in the system.
2. Use the right hose material for the application. Take into account pressure, volume passing through the hose, and chemical or environmental compatibility.

3.11 Shaker

A shaker is a piece of laboratory equipment used to mix, blend, or agitate substances in a tube or flask.

General SOP: Shaker Equipment

1. Operate the equipment at the ambient temperature specified by the manufacturer.
2. Use proper loading techniques and ensure items are loaded in a symmetric pattern.
3. Disconnect the power cord from the power supply during power outages to avoid unexpected start-ups.

3.12 Autoclave

Autoclaves and sterilizers have the potential for causing burns or cuts while handling or sorting hot sterilized items or sharp instruments.

General SOP: Using Autoclaves

1. Enforce the policy that all users must be trained to use the equipment.
   Biology autoclave use requires an online training course and user's name on the authorized user list maintained by the Biology Instructional Services facility.
2. Do not autoclave hazardous chemicals, such as solvents and preservatives.
3. Ensure that the autoclave/sterilizer door is closed and locked before beginning the cycle.
4. Do not remove items from an autoclave/sterilizer until they have cooled.
5. Avoid handling the sharp ends of instruments. Use forceps or other tools to remove sharp instruments from baskets and autoclaves.
   - If handling sharp items with the hands is necessary, use cut-resistant gloves.
   - Puncture-resistant gloves are now available. Intended for police and security personnel doing searches, consider making such gloves available if manual handling is absolutely necessary.
6. When necessary, use oven mitts, face shields, or other appropriate protective equipment for handling hot items and to protect from steam burns,
7. Protect hands when handling or sorting sharp instruments with cut-resistant gloves.

For additional details on autoclaving procedures, see the ***Campus Biosafety Program Manual*** or contact the BIS Facility in Biology.

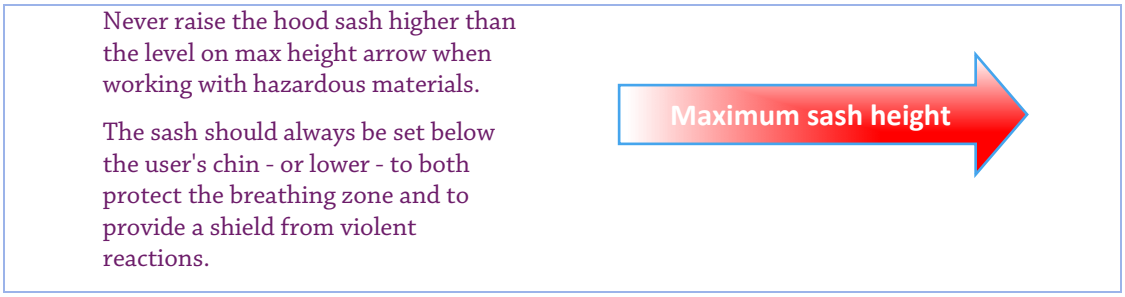
3.13 Chemical Fume Hoods

Chemical fume hoods are the most important controls used to protect laboratory workers from exposure to hazardous chemicals. They serve both to draw chemical vapors and gases away from the worker and to contain unexpected chemical reactions.

A. General SOP-Using Chemical Fume Hoods

1. Always work with the sash below the level of the red arrow showing maximum sash height and close it when not attended.
   - The average face velocity (at the sash) should be approximately 100 - 150 lfpm (linear feet per minute).
   - The red arrow indicates the maximum height the sash may be raised and still be able to meet minimum 100 lfpm average velocity.
   - The typical working sash height is typically between 12-18 inches.

Figure 4.2



2. Keep the sash as low as you can—below chin level—to better protect you from splashes and unexpected violent reactions
3. Always work at least 6 inches inside the hood to maximize capture efficiency
   - Place a stripe 6" inside the hood face as a reminder if it will help.
4. Raise equipment or larger apparatus to allow air to flow more freely under and around the object.
5. Check the air flow monitor on the hood. It was placed there to go into alarm if the air velocity drops too low.
   - If the alarm engages, lower the sash slightly until the alarm stops.
   - If this does not solve the problem, there may be a problem with the hood or monitor.
   - Do NOT disengage or override the alarm
   - Stop using the hood and contact your stockroom immediately
6. Store only a minimum of equipment and chemicals in your hood

- Excess materials can block the air flow into the intake slots at the back of the hood. Permanent equipment should be raised on a jack to allow the air to flow smoothly.
- Most fires and explosions occur in the hood. Minimizing chemical volumes will reduce the chances of a small accident escalating into a large one.

7. Keep the lab windows closed.
   - Drafts from open windows and doors can significantly affect your hood's performance (100 ft/min is only a few miles per hour of air)

B. General SOP: Chemical fume hood problems

Direct questions or requests for evaluation to your stockroom staff. The stockroom will work with EH&S to check the hood and submit a work request for repairs.

If you believe a fume hood is not working correctly, STOP using the fume hood until it has been tested and cleared by EH&S. DO NOT CONTINUE TO USE IT!

1. Stop what you are doing;
2. Close containers and stop experiments (if possible);
3. Pull the hood sash all the way down to close it;
4. Report your concern to your stockroom manager;
5. Post a sign indicating the hood is out of service

C. Limitations of chemical fume hoods

A chemical fume hood cannot provide absolute containment or absolute protection from the materials in the hood. However, a correctly designed hood in a properly ventilated room can provide adequate protection, as long as appropriate work practices are followed.

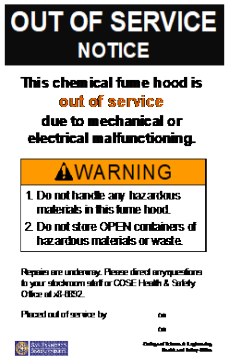
People working in the lab should have a basic understanding of the limitations of chemical fume hoods and how to use them properly to help ensure the hoods effectively direct vapors, fumes, and gases away from the user.

D. Operating requirements for chemical fume hoods

- All fume hoods are inspected and certified by the University EH&S department, or designated contractor, at least annually and marked with a compliance sticker.
- Per Cal/OSHA, hoods are required to operate at an average face velocity of at least 100 LFPM (lineal feet per minute) with a minimum of 70 LFPM at any point. When measuring the face velocity, the area at the face is divided into sections and readings are taken at each location.

- The maximum approved sash height must be marked on the hood face. The fume hood sash should be set between 12-18 inches high. Note: Operating the hood with a sash height higher than 18 inches could compromise the effective draw of the hood and may not protect the user's breathing zone and face from accidental splashes or contain unexpected reactions.
- Post a sign indicating the hood may not be used for hazardous materials if it is not working properly.

See §5154.1 "Ventilation Requirements for Lab-Type Hood Operations



Hood airflow monitors

D. Reasons Not To Use Fume Hoods for Storage

Although the practice is fairly common, avoid using chemical fume hoods to store chemicals. Storing chemicals in hoods limits work space, increases the chance for unwanted chemical mixing, and compromises air flow. Be sure to take these factors into account if work must be done in hood doing double duty as ventilated storage.

Reduce reliance on fume hood storage and reassess your storage practices. Things to try:

- Store fewer chemicals in smaller quantities,
- Share limited ventilated storage space,
- Consistently put chemicals away after using them in the hood,
- Choose alternate hazardous waste satellite accumulation areas. Waste usually *does not* have to be stored in a hood

E. Servicing flow rate monitors on fume hoods

Cal/OSHA requires all laboratory-type hoods to be equipped with a quantitative air flow monitor that continuously indicates whether air is flowing into the exhaust system during

operation. This requirement may also be met by an airflow alarm system if the system provides an audible or visual alarm when the air flow decreases to less than 80% of the required air flow. [8CCR§5154.1(e)] EH&S is responsible for ensuring these monitors are checked and calibrated at least annually.

F. Maximizing the effectiveness of fume hoods

Per Cal-OSHA regulations in 8 CCR 5141.1(f), users of hoods must be trained how to use the fume hoods safely; hood airflow characteristics and potential for hazardous substances escape; how to find the alarm system and how to read it; find the last performance test date and results.

3.14 Snorkels or Elephant Trunk Systems

A snorkel or elephant trunk is a piece of flexible duct or hose connected to an exhaust system. A snorkel is particularly effective for capturing discharges from gas chromatographs, pipe nipples, and pieces of tubing if the hose is placed directly on top of the discharge with the end of the discharge protruding to the hose.

General SOP: Snorkels or Elephant Trunks as Local Exhaust

1. Place the intake for the snorkel very close to the point source or it won't be effective.
2. Check the ductwork or trunk periodically for leaks.

3.15 Downdraft Table or Hood

Downdraft hoods or necropsy tables are specially designed work areas with ventilation slots on the sides of the work area. This type of system is useful for animal perfusions, gross anatomy laboratories, and other uses of chemicals where there is a need to have full access over and around the materials (which would be obstructed by the three sides of a chemical hood) and the chemicals in use have vapor densities that are heavier than air. These are tested annually.

General SOP: Using Downdraft Tables or Hoods

1. Get approval from EH&S before purchasing or using this system.
2. If ductwork is used in conjunction with a downdraft table, check ductwork periodically for damage or leaks.

3.16 Ventilated Balance Enclosure

Ventilated balance enclosures are commonly used in laboratories to weigh toxic particulates. These devices are installed with different specifications for face velocity than the standard laboratory chemical hood and are well suited for locating sensitive balances that might be disturbed if placed in a laboratory chemical hood. Ventilated balance enclosures are typically equipped with HEPA filters to remove hazardous particulates captured within the device prior to exhaust.

General SOP: Ventilated Balance Enclosure

1. Ensure the average face velocity should be about 75 fpm plus or minus 10 fpm.
2. Check that the sash and other components are not damaged.

3.17 Benchtop Ventilated Enclosure

Many laboratory ventilation system manufacturers offer ventilated enclosures that can be sized to fit equipment that would normally be placed in a chemical hood, such as rotovaps and microwave ovens. They can be made of metal or plastic and could have doors or sashes for access. The velocity of air will vary depending on the material being ventilated.

Nanomaterials—This type of local exhaust is usually required for work with nanomaterials. A filtration system effective for nanomaterials is part of the enclosure and must be used.

By placing larger equipment in a ventilated enclosure rather than a hood, the amount of space available in existing hoods is maximized.

General SOP: Benchtop Enclosure for Local Exhaust

1. Contact EH&S for review and approval before purchasing or using this type of local exhaust system.
2. Check that the size is adequate for your needs and that all safety features work correctly.

3.18 Slot Hood

Slot hoods are local exhaust ventilation hoods specially designed to capture contaminants generated according to a specific rate, distance in front of the hood, and release velocity for specific ambient airflow. To be effective, the geometry, flow rate, and static pressure must all be correct. Do not install a slot hood without consulting a ventilation engineer. EH&S approval for slot hoods is required to ensure it is set up to effectively exhaust contaminants.

General SOP: Slot Hoods

1. Contact EH&S for review and approval before purchasing or using this type of local exhaust system.
2. Have all the specifications of the hood system available for a ventilation engineer to review as your specific application is evaluated.

3.19 Canopy Hood

This type of local exhaust is not suitable for protection against hazardous contaminants. Canopy hoods are generally placed well above a contaminant source so that laboratory personnel can operate underneath them, they draw contaminants past the breathing zone

and into the exhaust system. Acceptable uses: Capturing heated air or water vapor from ovens or autoclaves.

General SOP: Canopy Hoods

1. Contact EH&S for review and approval before purchasing or using this type of local exhaust system.

3.20 Clean Bench or Laminar Flow Hood

A clean bench or laminar flow hood resembles a chemical hood but is not intended to provide protection to the user. On the top or back of the clean bench, HEPA filters pull room air through the filters and pass that air across the work surface, providing clean air. The clean bench is for product protection, not personal protection, and is not connected to the ventilation system. Mark such equipment "not for use with hazardous materials" to remind laboratory personnel not to use anything in it that they would not use on the benchtop.

Not for user protection. Do not use with hazardous or biohazardous materials.

3.21 Ductless Fume Hood

Air is filtered before exhausting into the room and is suitable for low hazard materials only. Mark such equipment "not for use with hazardous materials" to remind laboratory personnel not to use anything in it that they would not use on the benchtop.

At SFSU, these are not approved for work with hazardous materials. Do not use with hazardous chemicals or biohazardous materials.

3.22 Biosafety Cabinets

Biosafety cabinets (or biohoods) are designed for work with biological materials. Class II biosafety cabinets are used at SFSU and provide both user and product protection. Air inside the cabinet is filtered before exhausting back into the room. Biosafety cabinets must be tested annually and after being moved to a new location. EH&S arranges for the annual testing through an outside contractor.

General SOP: Using Biosafety Cabinets

1. Check that biosafety cabinets are tested and certified for use annually.
2. Check that the sash and other visible components are in good condition.

3. Use an ethanol solution or other approved disinfectant to wipe down items before removing them from the biosafety cabinet.
4. Do not overcrowd the interior or store items that block air flow.
5. If an ultraviolet light is being used to sterilize the interior, keep hands out of the cabinet while it is on.
6. Contact EH&S before relocating a biosafety cabinet or acquiring a new one so it can be tested and certified for use.

For more details, check the Campus Biosafety Program Manual or the CDC website.

Chapter 4.Signs and Labels

Lab personnel and visitors must be warned about significant hazards and precautions before they enter a space and be able to tell what is inside containers in these spaces. Mislabeling spaces or containers creates a higher risk situation because the true nature of the hazard is not known.

For laboratories meeting Cal/OSHA's definition, labeling requirements must comply with the Laboratory Standard which allows flexibility in how hazard communication is accomplished.

8 CCR 5191 (Lab Standard)

f) Employee information and training.

(1) The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area. Information and training may relate to an entire class of hazardous substances to the extent appropriate.

h) Hazard identification.

(1) With respect to labels and safety data sheets;

(A) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

4.01 Container Labels

Lab personnel must be able to tell what is inside a container in a lab.

Generally, labels are the best way to communicate this information.

However, in lab work, this is not always feasible or convenient.

In spaces with hazardous materials, **all containers must be labeled** with their contents, including non-hazardous materials such as deionized water and sugar solutions. For example: distilled water in squeeze bottles is a colorless liquid similar to other lab chemicals such as acetone, ethanol, or detergent solution.

A. Labels on Original Manufacturer Containers

1. Original manufacturer labels must meet the OSHA Hazard Communication regulatory requirements, including manufacturer contact information.
2. Labels must be legible and present.
3. Labels may not be defaced until the container is ready to be re-used.
4. If the original container will be re-used, completely remove or cover up the label so it doesn't show. Place the new label on the container according to the requirements for secondary containers.

B. General SOP: Secondary Container Labeling in Laboratories

A secondary or "transfer" container is not the original or primary container. It is a container which is used by personnel to hold materials transferred from the original container or materials mixed or created by the personnel in the space.

1. All containers that are not empty must have a label that is legible.
2. Labels must identify the contents.
   - Full name is required unless alternate labeling options are used as explained in #4 below.
3. Significant physical and health hazards must be communicated.
   - If the SDS or original container does not indicate the hazards because they don't meet GHS hazard definitions, then hazard information is not required.
   - To avoid issues during inspections, consider including a statement, such as, "No GHS Hazards". Using the words non-hazardous may not be accurate and should be avoided.
   - Containers of distilled, tap, or deionized water do not need hazard information on the label, but must still have an identifying label.
4. Alternate labeling and hazard communication strategies may be used as long as the identity and hazards are effectively communicated. All lab personnel must be able to access and present this information to inspectors and other visitors.
   - Faculty and staff supervisors (aka the Responsible Person) are responsible for ensuring accurate and timely communication of container contents and associated hazards.
   - The Responsible Person must be able to demonstrate the effectiveness of the chosen method of communicating hazard information.
5. Clean up spilled material on labels as soon as possible.
6. Replace damaged or illegible labels before they become unreadable.
7. Remove or completely cover up old and conflicting labels.

1. Alternate Labeling Options for Secondary Containers

The Laboratory Standard is a performance standard that allows laboratory operations the freedom to implement hazard communication techniques that work for them. Below are examples of alternate labeling options.

- Tiny containers: Place a code on each tube or vial. Put a larger label identifying the contents of the tubes on the rack or holding container. Code must be matched by the relevant note in the lab notebook or on a posting.

- Greasy, Steamy, Unlabel-able containers: Place a sign or label on the hood or next to the container explaining what is inside the container(s). Include a brief description of the experiment in progress or the experiment name and hazard information. Alternatively, place such containers into a larger container that can be labeled.
- Containers with long identifying information: May use an abbreviation or nickname but full information must be available nearby. A posting, lab notebook reference, or file associated with the container that is accessible by room occupants and visitors.

2. Beverage and Food Containers in Labs

Food, condiments, or drinks are not permitted in hazardous materials areas.
Food or drink containers are not permitted to be used to store laboratory supplies or chemicals.

- There is a real risk of room occupants mistaking a material in a beverage container with something drinkable.
- Consumer plastics are often flimsy and not resistant to common lab chemicals. Leaks and spills from these containers are common.

D. Labels on Byproducts or New Chemical Compounds

Researchers sometimes create new chemical substances with no published toxicity information. This can pose hazards to your lab workers because chemical mixtures can be more toxic than the individual components alone.

If you produce a chemical exclusively for your laboratory or it is a by-product of your research, try to identify its hazardous properties

1. General SOP: Labeling Lab-Made Chemicals

1. Assess the hazards based on your experience and knowledge of the components.
2. Assume the substance is hazardous if you aren't sure what the components are.
3. Place a label on the container with its "name" or identification and likely hazards. Also include the date, the name of the person who made it, and the name of the research lab.
4. If you don't know the hazards, write "*Toxicity Unknown. Avoid Exposure. Handle with Care*." on the label as a precaution and limit access to the material.
5. Where the exact name of the compound or mixture is unknown, "identification" can be a chemical structure along with a reference to a laboratory notebook.
   Make sure you can justify why the material name cannot be used and can demonstrate how your labeling system effectively communicates hazard information.
6. Train lab workers so they can handle the substance safely and know how to label the container (see #3) and dispose of it correctly.

2. General SOP: Labeling on Research Samples

Label research samples and materials as instructed in section 1B for secondary containers.

1. Assess the hazards as explained above and add the additional information below:
   - Date sample was prepared
   - Name of researcher who created the sample or material
   - Name of research group or PI
2. When possible, record the end date on the samples so they can be disposed of when no longer needed.

4.02 Cabinet and Equipment Labels

Equipment and hazardous materials storage cabinets, environmental chambers, and refrigerators, freezers, and microwave ovens also have labeling requirements. Contact EH&S if you are not sure if warning labels are required for your equipment or storage units.

A. Equipment Labels

Equipment purchased commercially should already have the required labels. Labeling requirements vary with the type of equipment and how each type is regulated. Before installing new equipment and periodically, check that the appropriate labels are still there and are legible. Equipment made or modified in-house may need labels affixed to them if required by the regulation that applies to them.

Equipment such as refrigerators, freezers, and microwave ovens must have "Not for Food or Beverages" or equivalent labels on them to make sure they are not used to store consumables for humans. A biohazard label must be affixed to this equipment if used for BSL-2 infectious materials. Refrigerators or freezers must have labels identifying whether the equipment is approved or is not approved for flammable storage. B

Note: If such equipment is available in office, break, or meeting areas in the laboratory suite, affix labels that say "For Food Only" or equivalent to prevent their use for laboratory materials.

B. Cabinet Labels

Cabinets (or drawers, boxes, and other containment) that are used to store hazardous materials must be labeled with the hazard class or type of the contents. Commercial flammable storage cabinets will have the necessary labels affixed by the manufacturer.

- Simplifies putting lab chemicals in the correct cabinet.
- Can prevent storing incompatible chemicals in the same cabinet.

- Allows inspectors to check for storage compliance more quickly, thus reducing the time spent in the lab.

Recommendation: Label the secondary containment tray used to contain leaks or to segregate incompatibles stored in the same cabinet. This will help to keep the cabinet organized.

4.03 Room Signs

At SFSU, rooms designated as containing hazardous materials should have a sign posted at the entrance(s) indicating the hazard. Personal protective equipment required for entry should also be posted along with the hazard information.

Post signs designating areas that are meant to be separated, such as laser control areas in a larger room.

4.04 Warning Signs

Warning signs must be posted where failure to notify workers or the public could result in injury or property damage as required by the Cal/OSHA Accident Prevention Signs standard in 8 CCR 3340.

- "Danger" signs must only be used when an immediate hazard exists.
- "Warning" signs indicate a potentially hazardous situation which, if not avoided, could result in death or serious injury.
- "Caution" signs must be used only to warn against potential hazards or to caution against unsafe practices.

The presence of biohazards in a room or on equipment must be posted. For the purposes of the CHP, biohazards are considered those that pose a risk of infection to humans. See the Campus Biosafety Program Manual for more information on signs and labels for biohazards.

A. Standard meanings to the colors and language in warning signs

Most people are familiar with OSHA warning signs that say "CAUTION" or "DANGER". It is acceptable to use the older (1971) OSHA sign system, however the campus prefers to use the analogous ANSI *(American National Standards Institute)* sign system whenever possible. A few years ago, new OSHA regulations went into effect that incorporate the latest ANSI Z535 (2011) standards, effective September 11, 2013.

Figure 3.1 Old vs New Safety Sign Designs

Warning signs are posted for a reason.

Emphasize the importance of paying attention to them.

1. The meaning of "signal words" on the OSHA or ANSI signs and labels

In choosing a "signal word", there are two questions to ask:

(1) If the safety label's message is ignored, how severe will the injury be?
   a. If the answer to "death or serious injury"? is YES, then the choice is between DANGER and WARNING
   b. If the answer is NO, the correct signal word is CAUTION.

(2) If the safety label's message is ignored, how likely is it that an injury will occur?
   a. If it is highly likely (a ***will*** situation), the correct signal word is DANGER.
   b. If it is a possibility (a ***could*** situation) the correct signal word is WARNING.

Figure 3.2 Danger vs Warning

DANGER ***DANGER*** indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

WARNING ***WARNING*** indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION ***CAUTION*** indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices." Note: This is no longer used as a signal word in OSHA Hazard Communication GHS labeling system.

B. Differences between NFPA diamond signs and HMIS stacked bar warning systems

For now, both the NFPA Hazard Identification System and the Hazardous Material Identification Guide /System (HMIG or HMIS) may be used to comply with the labeling requirement of the OSHA Hazard Communication Standard (HCS). These systems, although similar, differ in some important respects. The most significant difference is the intended audience.

NFPA –to alert fire fighters of the hazards in the event of a fire
HMIS – to alert employees who handle chemicals in the workplace

See Figure 3.3 for more details on each system.

Figure 3.3 HMIS vs. NFPA

HMIS Label Example

NFPA Example

For more info on these labeling systems:

HMIS and NFPA Labeling Systems

Similarities

- Both systems have three color-coded fields to indicate the flammability (red), health (blue), and reactivity (yellow) hazards
- present at that location. associated with the material.
- Both use a system of five numbers, ranging from 0 to 4, to indicate the severity of hazard, with 0 being the least and 4 being the most hazardous.

Differences

- They differ in layout – NFPA uses four diamonds, HMIG uses vertically stacked bars.
- The differ in interpretation of the fourth, white field (special handling in the NFPA system; protective equipment in the HMIG system).
- The HMIG (or HMIS) was devised as an HCS compliance tool, and has employees who must handle hazardous chemicals in the workplace as the intended audience. The NFPA system was designed to alert fire fighters arriving on the scene of a fire to the hazards associated with materials
- Therefore, the numbers assigned in the NFPA system **assume that a fire is present**. No such assumption holds in the HMIG/HMIS system. For this reason, the numbers that are assigned to the flammability, health, and reactivity hazards may differ between the NFPA and HMIG systems, even for the exact same chemical.

Note about chemical hazard labels: In GHS hazard categories, Category 1 is low hazard, while Category 4 is a high level of hazard. This is opposite from NFPA and HMIS.

Chapter 5.Chemical Procurement

Certain chemicals and equipment that have safety or environmental regulatory requirements require EHS approval for purchase or acquisition.

5.01 Purchase of Hazardous Materials

The purchase of certain hazardous materials that pose special safety, regulatory, or storage risks must be reviewed for compliance, safety, facility capability. SFSU Procurement and EH&S have worked together to develop new purchasing rules for improved oversight of such purchases.

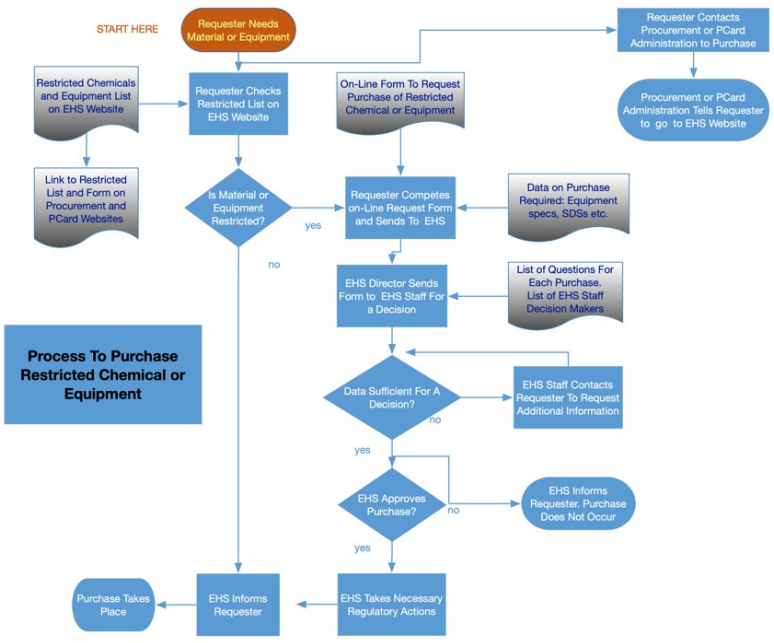
A. Procedure for Purchases Requiring EH&S Review

Go to EHS website and follow the *Process Flowchart to Purchase Restricted Chemical or Equipment*

Review the *Restricted Chemicals and Equipment List*

1. If your desired purchase is on the list,
    a. fill out the *Request for EHS Approval to Purchase Restricted Chemicals or Equipment* and the
    b. *Information About Requested Chemical or Equipment Form*
2. Send the form to EHS: sfehs@sfsu.edu
3. Wait for letter of authorization or explanation of denial

Figure 5.1



B. Considerations Before Ordering Chemicals

Avoid purchasing chemicals in bulk because of the strain on limited space, the expense of ultimate disposal of unused quantities, and the potential hazards caused by large quantities in a small space.

- Before receiving a hazardous material, make sure you have the SDS and know how to safely store and handle it.
- Reject any container without a label specifying the contents and significant hazards.
- Make sure you have an appropriate and compliant place to store it.
- If prior approval is required by the Director of EHS ensure that you have it before the purchase.

C. Transfer of Hazardous Materials

Hazardous materials may be transferred from one SFSU employee to another, as long as all regulatory requirements are met. Both the donor and recipient must adjust their hazardous materials inventory accordingly.

5.02 Donation of Hazardous Materials

SFSU does not accept donations of hazardous materials, including lab chemicals.

If an exception to this policy is critical to research or instructional needs, the Chemical Hygiene Officer and EH&S Director must preapprove the donation BEFORE the shipment arrives.

Donated chemicals are usually at or near their expiration date or are in quantities that you won't be able to use up.

- Although this does save the donating company the expense of disposing of these chemicals, this means SFSU ends up paying for the disposal.
- Disposal costs are expensive and the campus will spend much more than the initial cost savings to you.
- The University is then the new generator of the waste and is responsible for it forever. The EPA (Environmental Protection Agency) uses the phrase, "from the cradle to the grave".

Chapter 6.Chemical Distribution and Storage

Chemicals and other hazardous materials must be handled and stored in a manner suitable for the type of material that will prevent spills and unwanted reactions.

6.01 Best Practices For Receiving Hazardous Materials

Once hazardous materials are received by laboratory personnel, the responsibility for their management becomes the responsibility of the Responsible Person (RP)—principal investigator or lab supervisor. To make management of chemical containers and the inventory easier, use the following best practices:

- Purchase chemicals in the smallest quantities possible.
- Whenever possible, buy your chemicals pre-mixed. Often the most hazardous task is mixing chemicals in powder form to make your own solution
- Use a reputable vendor and make sure the Safety Data Sheet comes with the shipment
- Add the new materials to your hazardous substance inventory
- Write the date received and your lab name on containers
- Record the "date opened" when opening a new material
- When stored in the lab, remove outer shipping package

6.02 Moving chemicals, cryogens, and gases

The act of transporting a hazardous substance comes with a risk of spills, heavy items falling on feet, shattered glass, and possible exposure to the public. For specialty items, such as compressed gas cylinders and cryogens, equipment designed to move them is available.

General SOP: Moving chemicals or hazardous waste to another location

Overturned carts, dropped containers, and people accidentally running into personnel while moving chemicals or hazardous waste from one location are common causes of spills. Unwanted chemical exposures, damage to floors, and unknown dangers from mixing of incompatible chemicals are examples of what can happen from such spills..

1. When transporting chemicals outside the laboratory or between stockrooms and laboratories, use only break-resistant secondary containment.

2. Check elevators for passengers when chemicals or hazardous waste must be transported between floors. Passengers should not be in the elevator. Use service elevator when possible.
3. Use re-sealable plastic bags or other adequate secondary containment for small samples.
4. Use appropriate chemical transport carts when moving larger liquid containers, especially if made of glass.
5. Commercially available secondary containment is made of rubber, metal, or plastic, with carrying handle(s), and is large enough to hold the contents of the chemical containers in the event of breakage.
6. Use white poly carts to move hazardous waste to the central hazardous waste storage shed. These are safer when rolling over asphalt outdoors.

A. Moving Cryogens

Cryogenic substances, such liquid nitrogen, can render the container brittle and easily breakable. Cryogens can freeze human tissue on contact resulting in chemical burns and possibly permanent damage.

General SOP: Transporting liquid nitrogen and other cryogens

1. Use containers designed for transporting cryogens.
2. When cylinders must be transported between floors, passengers should not be in the elevator. Use service elevator when possible.
3. Wear gloves designed to protect against cryogens.

B. Moving Gas Cylinders

Protect the cylinder valve. Most of the handling rules are designed to prevent the valve from leaking or breaking.

General SOP: Transporting liquid nitrogen and other cryogens

1. Check that the receiving location is prepared to receive the cylinder.
   - If area doesn't have cylinder straps or chains in place, do not deliver it until they are in place. Never leave unsecured gas cylinders unattended.
2. Screw on the protective cover cap. Do not move a gas cylinder with its regulator installed.
3. Strap the cylinder in a cylinder cart designed for this purpose.

4. When cylinders must be transported between floors, passengers should not be in the elevator. Use service elevator when possible.

6.03 Standard Chemical Storage Practices

Standard safe chemical storage practices include maintaining good housekeeping, sorting chemicals by hazard class and type before alphabetizing them, and keeping incompatible chemicals separated by space, cabinet, or secondary containment or spill tray.

Hazardous substances that are especially toxic or reactive must be carefully and securely stored to prevent unauthorized access and inadvertent exposure.

A. Low Hazard Chemical Storage

Weak acids and bases with pHs in the neutral range, as well as other chemicals that have no GHS defined hazards or are very dilute may be stored together in the general lab reagents area. Store liquid and dry chemicals separately before alphabetizing the containers.

B. General SOP: Corrosives–Acids and Bases

As a general rule, strong acids and strong bases (corrosives) must be stored separately from each other because they react vigorously when mixed.

1. Segregate strong corrosives using plastic trays, tubs or buckets when stored in the same cabinet. Metal containers will corrode over time.
2. Use cabinets made of plastic or metal cabinets with a corrosion-resistant lining to store strong acids whenever possible.
3. Store on low shelves. Shelves above shoulder height (~4 feet) are unacceptable for storing corrosives.
4. Keep strong acids and bases away from the following substances:
   - Active metals such as sodium and potassium
   - Chemicals that could generate toxic gases when mixed, such as sodium cyanide and iron sulfide.

Figure 6.1 Examples of Corrosives

Mineral Acids		Organic Acids	Bases
Hydrochloric acid	Chromic acid*	Glacial acetic acid	Ammonium hydroxide
Phosphoric acid	Perchloric acid*	p-Toluenesulfonic acid (PTSA) or tosylic acid (TsOH)	Potassium hydroxide
Hydrofluoric acid	Nitric acid*		Sodium hyrdoxide
Hydrobromic acid*	Sulfuric acid*		

**indicates strong oxidizing acids*

1. General SOP: Concentrated Mineral/Inorganic Acids

- Segregate concentrated mineral acids, such as hydrochloric acid (HCl), and sulfuric acid (H_2SO_4), as they are very reactive, even with each other.
- Store nitric acid separately, is it reacts with both mineral and organic acids (i.e., acetic acid and hydrochloric acid). Use secondary containment when stored with other chemicals.

- Fuming nitric acid is extremely reactive and will cause a fire upon contact with nitrile or latex gloves, as well as other organics. Use only if there is no suitable substitute.
- Store inorganic acids away from organic solvents and other organics. Aside from being reactive, concentrated sulfuric acid and nitric acid are also oxidizers.

2. General SOP: Concentrated Organic Acids

1. Store corrosives in acid resistant containers. Avoid metals.
2. Do not store concentrated organic acids (i.e., acetic acid, formic acid) with concentrated mineral acids in the same cabinet whenever possible.
   - Strong or concentrated glacial acetic acid MUST be kept in a separate cabinet from concentrated nitric acid.
2. Combustible concentrated organic acids such as glacial acetic acid (NFPA Class II) and formic acid (Class IIIa), may be stored in flammables storage cabinets if a separate cabinet for organic acids is unavailable.
   - Store in secondary containment to segregate from flammable solvents in a flammables storage cabinets.
   - Storage with other organics and non-flammable halogenated solvents is acceptable when segregated with secondary containment.

3. General SOP: Bases/Caustics

Anhydrous bases, such as sodium hydroxide, react strongly with water. Upon skin contact, the moisture in the skin reacts with the powder to cause severe chemical burns. Bases are highly reactive to metals, strong acids, oxidizers, and water.

1. Store strong bases in non-metal containers or cabinets made of or lined with resistant material.
2. Store in separate secondary container from acids, oxidizers, and organic solvents.
3. Avoid using bases in powder (anhydrous) form. Purchase pre-mixed solutions when possible.

4. Oxidizing Acids

Certain inorganic acids are known oxidizers, such as nitric acid. The higher the concentration, the stronger the oxidizing property. Oxidizing acids react strongly with organic materials. Although not flammable themselves, these acids provide the oxygen needed to allow a fire to flourish if present in the area. See Oxidizer section for more storage considerations.

C. General SOP: Oxidizers

Oxidizing chemicals initiate or promote combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

1. Store away from organic, flammable, dehydrating or reducing agents.
2. Avoid long-term storage in wooden cabinets.
3. Provide secondary containment—especially for strong oxidizing acids.
4. Do not use corks or rubber stoppers.

The following chemical classes are considered oxidizers:

inorganic peroxides–noncombustible, react vigorously with water, can react with organic substances to cause fire

nitrates–non-combustible, but enhance combustion of other substances. May become shock sensitive when mixed with organics

organic peroxides–unstable, highly reactive and extremely flammable in the dry, crystalline state. Highly sensitive to heat, light, friction, and strong oxidizing and reducing agents

perchlorates–stable under normal conditions, but may become explosive when mixed with combustible materials

Figure 6.2 Examples of Oxidizers

Solids		Liquids		Gases
Sodium nitrite, Iodine, Nitrates	Salts of Potassium ferricyanide	Nitric acid	Hydrogen peroxide	Oxygen
Salts of peroxides		Perchloric acid	Bromine	Nitric Oxide
		Chromic acids		Nitric Dioxide

D. General SOP: Peroxide-Formers

When exposed to air, they can form peroxides that can explode if concentrated by distillation or evaporation. Light exposure may also exacerbate peroxide formation. In addition, they may react violently with halogens and strong oxidizers (i.e., nitric acid).

1. Never open a dented or otherwise compromised container
2. Keep container tightly closed.
3. Upon receipt, place the date received on the container. Adding the date opened as well is highly recommended.
4. Keep container tightly closed.
5. Maximum storage time for is one year or the manufacturer's expiration date, whichever comes first.
6. If crystals have formed around the top, do not touch. The container may be shock sensitive. Contact your stockroom.
7. Do not store – even temporarily – in direct sunlight or near heat sources

Figure 6.3 Examples of Chemicals that Form Peroxides with Aging

Class III - May explode without concentration being required	Class II - May explode upon concentration, distillation, evaporation	Class I - May polymerize violently due to peroxide initiation
Isopropyl ether	Diethyl ether	Acrylonitrile
Potassium metal	Tetrahydrofuran	Styrene
Sodium amide (sodamide)	Cyclopentene, Cyclohexene	Methyl methacrylate

D. General SOP: Water Reactive Substances

Water reactive substances react violently with water releasing heat and, in some cases, explosive by-products. Alkalai metals react strongly with water to form hydrogen gas. The reaction is exothermic and the heat generated can ignite the hydrogen gas

1. Rigorously prevent exposure to water and air. Store alkali metals under mineral oil or in an inert atmosphere
2. Store away from oxygen, acids, halogenated solvents, and carbon dioxide
3. Assume that containers with alkali metals contain flammable hydrogen gas in the head space, even if stored under mineral oil or an inert gas. Thus, no source of ignition should be present where these containers are opened.
4. Use non-sparking tools, such as brass, to open containers.

Materials with a yellow or orange coating can indicate the presence of peroxides—which may detonate if cut or abraded.

Figure 6.4 Examples of Water-Reactive Chemicals

Solids	Liquids
Calcium carbide	Phosphorous trichloride
Magnesium, lithium, potassium, sodium	Thionyl chloride

E. General SOP: Pyrophoric or Air Reactive Substances

Pyrophoric materials—also called air reactives—are substances that spontaneously ignite upon exposure to oxygen. Some can also be water-reactive, where heat and hydrogen (a flammable gas) are produced.

1. Store under an atmosphere of inert gas or under mineral oil
2. Do not allow pyrophoric chemicals stored in solvent to dry out.
3. Check periodically to ensure there is a visible amount of solvent in the bottle
4. Store away from flammables.
5. Write the date the container was first opened.
6. Do not store past the manufacturer's expiration date.

Figure 6.5 Examples of Known Pyrophoric Chemicals

Finely divided metal powders	Metal hydrides
White phosphorus	Lithium aluminum hydride, potassium hydride
Alkyllithiums	Non-metal hydrides and alkyl compounds
Some organometallic compounds - $LiAlH_4$, $Al(CH_3)_3$,	Silane
	Magnesium amide

6.04 Particularly Hazardous Substances

OSHA's Lab Standard addresses work with "Particularly Hazardous Substances" (PHS) – refers to substances particularly hazardous to human **health**. The term PHS refers to "select carcinogens", "reproductive toxins", and "substances with a high degree of acute toxicity".

For details on the safe use, storage, and disposal of these substances, see **Chapter 7**.

6.05 Flammable Materials

Flammable and combustible liquids ignite easily and burn rapidly. Flammability is determined by the flash point of a material. Flashpoint is the minimum temperature at which a liquid forms a vapor above its surface in sufficient concentration that it can be ignited.

Usually, the vapor burns, not the liquid itself. The rate at which a flammable liquid produces flammable vapors depends on its vapor pressure. For this reason, volatile organic compounds (VOCs), that evaporate quickly, tend to be flammable.

A. General SOP: Storing Flammable Liquids

1. Store flammable liquids away from spark sources and open flames.
2. If flammables must be refrigerated or frozen, an approved* flammables safe or explosion-proof unit is required. An "approved" unit is one that has been designed for the storage of flammable materials and is UL* listed. *Underwriters Laboratories
3. Store flammable liquids off the floor. Store glass bottles in secondary containment.
4. Store extremely flammable liquids (NFPA Class1A or GHS Category 1) in approved* flammables storage cabinets when not being used, regardless of the quantity.
5. Store flammable solvents separately from non-flammable halogens, as they can combine to form poisonous phosgene gas in a fire.
   - Store flammable halogenated solvents, such as 1,2-dichloroethane, with the other flammable solvents in a separate secondary container.
6. Store flammable solvents away from distillation units – do not store underneath.
7. Store oxygen and other oxidizing gases at least 20 feet away or separated by a firewall.

1. Approved Flammable Storage Cabinets

Approved* flammable storage cabinets meet California Fire Code requirements. They are designed to store flammable liquids and protect the contents from a fire *outside* the cabinet. Cabinets that do not meet the criteria below are not "approved cabinets" and so are merely "cabinets" whether they hold flammables or not.

- California Fire Code CFC 5704.3.2.1.3 (self-closing doors)
- Cal/OSHA 24 CCR 7902.5.9
- NFPA 30
- OSHA 29 CFR 1910.106(d)(3)

- UL 1275 Listed

*Cal/OSHA 8CCR 5533 Design, Construction and Capacity of Storage Cabinets

*IFC (International Fire Code) 5704.3.2.1.3: “Doors shall be well fitted, self-closing and equipped with a three-point latch.” (Same citation in 2019 CA Fire Code, Title 24, Part 9)

2. Venting Flammable Storage Cabinets

Ventilation for flammable storage cabinets is not required or recommended by the National Fire Protection Association (NFPA) or the California Fire Code (CFC). Vent openings shall be sealed with the bungs supplied with the cabinet.

If ventilation is desired, contact the EHS for a preliminary evaluation. If the evaluation is approved, the work will need to be performed by Facilities. Venting shall be to the outside, not recirculated into the room.

To control odors, check containers for leaks, spills, and loose caps and correct issues. If necessary, consider additional options, such as vapor absorbents or relocating some containers

3. Storage Limits for Flammable Liquids

Many SFSU buildings do not have sprinkler systems. Because of this, the maximum flammables storage is half that of building with sprinklers. To be on the conservative side, the campus uses the maximum storage limits specified for Class I flammable liquids. This has the advantage of being easy to comply with and monitor. Note that this policy is for all rooms except solvent storage rooms which have a fire suppression system and fire walls.

NFPA 45 Policy:

The maximum volume of flammable liquids (NFPA Class I, II, II combined) that may be stored outside of an approved flammables cabinet or solvent storage room is based on NFPA 45, "Fire Protection for Laboratories Using Chemicals"

Per room ≤ 600 ft² – 6 gallons (23 liters)

Per room > 600 ft² – 10 gallons (38 liters)

This means that if you have more than this amount stored in any one room, those containers must be stored in an approved flammables cabinet or moved to another room. GHS Category 1, 2, 3, and 4 will be considered flammable liquids in lieu of using NFPA classes when applicable.

California Fire Code "Fire Control Areas" restrictions may also apply per the discretion of the State Fire Marshal.

Figure 5.5 GHS Categories of Flammable Liquids and Corresponding NFPA Classes

GHS Category 1 - Flash point < 23°C (73°F) and initial boiling point ≤ 35°C (95°F)	
Chemical Name	NPPA Class (FP <74° F, BP <100° F)
Acetaldehyde	1A
Chloroethane	1A
Diethyl ethyl ether	1A
Ethyl ether	1A
Ethylamine	1A
Ethylene oxide	1A
Furfuran	1A
Isopropyl chloride	1A
Methyl chloride	1A
Methyl ethyl ether	1A
Pentene	1A
Petroleum ether	1A
Propylene oxide	1A

GHS Category 2 - Flash point < 23°C (73°F) and initial boiling point > 35°C (95°F)	
Chemical Name	NPPA Class
Acetone	1B
Acetonitrile	1B
Acrolein	1B
Acrylonitrile	1B
Benzene	1B
Camphor oil	2
1,1- dichloroethane (Ethyl dichloride)*	1B
1,2- dichloroethane (Ethylene dichloride)*	1B
1,2- dichloroethylene (trans-Acetylene	1B
Ethyl acetate	1B
Ethyl alcohol	1B
Gasoline	1B
Hexane	1B
Isopropyl alcohol (2-Propanol)	1B
Methyl alcohol (methanol)	1B
Methyl ethyl ketone	1B
Methyl isobutyl ketone	1C
Pentane	1A
Petroleum ether (Naphtha solvent)	1C
Propyl alcohol (1-Propanol)	1C
Tetrahydrofuran	1B
Toluene	1B

*Flammable Halogenated Solvents

GHS Category 3 - Flash point ≥ 23°C (73°F) and ≤ 60°C (140°F)	
Chemical Name	NPPA Class
Acetic acid, glacial	2
Amyl alcohol	1C
Butyl acetate	1B
Butyl alcohol	1B
Cellosolve acetate	2
Chlorohexane	1C
Dibutyl ether	1C
Diesel fuel	2
Formaldehyde	3A
Formic acid	3A
Isoamyl acetate	1C
Isoamyl alcohol	2
Isobutyl alcohol	1C
Stoddard solvent	2
Styrene	1C
Xylene	1C

GHS Category 4 - Flash point > 60°C (140°F) and ≤ 93°C (200°F)	
Chemical Name	NPPA Class
Aniline	3A
Benzaldehyde	3A
Carbolic acid	3A
Dichlorobenzene	3A
Diethyl glycol	1C
Furfuryl alcohol	3A
Hydrazine	2
Kerosene	2
Nitrobenzene	2

2. General SOP: Storing Flammable Solids

A flammable solid is a solid which is readily combustible, or may cause or contribute to a fire through friction. Readily combustible solids are powdered, granular, or pasty substances which are dangerous if they can be easily ignited by brief contact with an ignition source. Many flammable solids such as sulfur, calcium carbide and white phosphorous can ignite in the presence of air or oxygen and continue to burn until the material is spent.

Flammable solids are more hazardous when widely dispersed in a confined space (e.g., finely divided metal powders). When burning, many of these are difficult to extinguish with water.

1. Store with other compatible flammable solids in a glove/drybox, inert gas-filled desiccator, or dedicated flammable storage cabinet. Keep dry.
2. Segregate from the following hazard classes:
   - Oxidizers
   - Flammable liquids
   - Water and aqueous solutions
3. Do not store or use near open flames and ignition sources.
4. Wear a fire-resistant lab coat when using or handling flammable solids.
5. Always follow the experiment SOP exactly using the quantity and equipment specified.
6. For flammable metal powders, have sand or a Class D fire extinguisher available in case of fire.

Categories of Flammable Solids

The above SOP describes general safe storage practices. Consider the additional hazards posed by flammable solids that are also spontaneously combustible and water reactive. Follow a substance-specific SOP for those with special hazards.

- **Flammable Solids** are readily combustible, or may contribute to a fire through friction. These include:
  - Flammable solids
  - Self-reactive substances
  - Solid desensitized explosives
- **Spontaneously Combustible** materials are liable to spontaneous generation of heat during transportation which can then lead to a fire. These include:
  - Pyrophoric substances

- Self-heating substances
  - **Water Reactive** (also called dangerous when wet) substances emit a flammable gas when in contact with water.

6.06 Specific Chemical Storage Practices

A. General SOP: Glacial acetic acid

Concentrated acetic acid is a NFPA/ IFC Class II flammable liquid –combustible – with a flashpoint at or above 100°F. In addition, it is very reactive with inorganic acids -- especially nitric acid. The GHS system in the HazCom Standard designates this as a Category 3 flammable liquid and a Category 1 corrosive.

1. Store acetic acid in flammables cabinets or with organic solvents if a separate organic acid cabinet is unavailable.
2. Keep away from open flames and oxidizers.
3. Never store oxidizing acids (like nitric acid) and acetic acid next to each other.

B. General SOP: Hydrofluoric Acid

Hydrofluoric Acid (HF) is a clear, colorless, fuming, very toxic liquid. Hydrofluoric Acid is also available in the gaseous state. All forms including the solution or the vapor can absorb through skin into the bone, attacking the calcium, and cause serious toxic systemic effects. HF is also corrosive but not as strong a corrosive as other common inorganic acids.

This is a Restricted Chemical.
Purchase of HF is prohibited without prior approval of the EHS Director.

1. Store hydrofluoric acid (HF) solutions in chemically compatible containers such as Teflon or polyethylene. HF dissolves glass!
2. Keep away from ammonia, bases, and organic solvents
3. Store at or below chest level
4. Place a warning sign on the cabinet door
5. Collect HF waste in strong plastic containers—do not use glass waste containers!
6. Have calcium gluconate, an antidote, and emergency procedures available in the lab in the event of skin contact.

C. General SOP: >70% Perchloric Acid

Concentrated perchloric acid is a strong oxidizer and corrosive. Concentrations of less than or equal to 70% are considered stable and are not restricted at SFSU.

This is a Restricted Chemical.
Purchase of >70% perchloric acid is prohibited without prior approval of the EHS Director.

1. Store away from acetic acid, acetic anhydride, alcohols, dehydrating agents, organic chemicals, and combustible materials such as wood or paper.
2. Write the date opened on the container.
3. Opened containers may be stored up to one year.
4. Inspect perchloric acid periodically for discoloration.
5. Decontaminate perchloric acid work areas using a 10% sodium carbonate solution
6. Perchloric Acid, if heated, must be used in a specially designed Perchloric Acid washdown fume hood, that can't be used for anything else.

D. General SOP: Nitric Acid

To be added in the next update

E. General SOP: Flammable Halogenated Solvents

To be added in the next update

Chapter 7.Particularly Hazardous Substances (PHS)

Cal/OSHA's Laboratory Standard requires the CHP to include provisions for additional employee protection for work with particularly hazardous substances (PHS) that include the following types:

- select carcinogens
- reproductive toxins
- substances which have a high degree of acute toxicity.

When establishing special precautions for Particularly Hazardous Substances, implement the following practices, where appropriate*:

- Establishment of a designated area
- Use of containment devices such as fume hoods or glove boxes
- Procedures for safe removal of contaminated waste
- Decontamination procedures

*According to "Prudent Practices in the Laboratory" "in some circumstances, it may not be necessary to employ all of these special precautions, such as when the total amount of an acutely toxic substance to be handled is a small fraction of the harmful dose." Review the individual SDS for toxicity information.

Special Precautions

These special precautions are internal to the departments, administrative units, and research labs covered by this CHP.

Laboratory personnel should consult with PI / Laboratory Supervisors (the Responsible Person or RP) on the following higher-risk chemical usage and operations in their laboratories, so that special safety precautions can be taken where appropriate:

1. Work involving Particularly Hazardous Substances or highly reactive materials.
2. A procedural change that significantly increases the overall hazard of an existing procedure, such as introduction of a high hazard chemical in a procedure, or scale-up of an experimental procedure or operation.

   Careful consideration of scaled-up work is critical to plan for the effects caused by an increase in chemical concentration/quantity and differences in dissolution rate and heat transfer.

3. Unattended operations that represent significant likelihood of fire, explosion, or exposure to personnel if a malfunction were to occur (such as a utility outage, runaway reaction, broken container, or chemical spill).

4. Working alone in the laboratory.

   Each case should be evaluated on a case-by-case basis to determine if working alone will be permitted, considering:

   - Task and hazards involved in the work.
   - Consequences resulting from a worst-case scenario.
   - The possibility of an accident or incident that would prevent the laboratory personnel from calling for help.
   - The laboratory personnel's training and experience.
   - The laboratory personnel's physical conditions or handicaps [consult with local Human Resources Officer for guidance and compliance with Americans with Disabilities Act (ADA)].
   - Time the work is to be conducted (during normal business hours, e.g., 7 am – 8 pm Monday through Friday) versus at night or on weekends/holidays.

For more details about requirements for working with PHSs, see ***Appendix B***, "Particularly Hazardous Substances".

Chapter 8.Training and Information

Employees working in laboratories subject to the Cal/OSHA Laboratory Standard must be trained in applicable Safe Operating Procedures and Institutional Policies and protocols.

Personnel working in labs (and stockrooms, etc.) are required (as shown on the CSU Master EHS Training Matrix for SFSU) to take the general on-line Lab Safety Fundamentals course. This course is available on iLearn, CSU-Learn, and CSU-Bridge so that employees will have appropriate access to the course. (This requirement will be implemented starting with the Fall 2021 semester.)

The additional safety training required of persons in working in laboratories is lab-specific, defined by the hazards they may be exposed to while working in the lab. These hazards are well defined by the ASSESS software tool that lab responsible persons complete for their labs, and lab members review and approve.

On-line courses found in CSU-Learn address many of the general EH&S training requirements defined by the ASSESS process. Where on-line courses are not available, required training is supplemented by instructor-led courses. (Refer to the CSU Master EHS Training Matrix for SFSU for examples.)

When the training options above are not adequate to address lab-specific hazards, the lab's Responsible Person is required to ensure that all personnel are trained to recognize and safely deal with those hazards.

Whenever possible such training shall be based on written SOPs and documented.

An asterisk * appears next to courses on the CSU Master EHS Training Matrix for SFSU which may apply only to designated students, as opposed to an "x" which refers to a course all students must take.

Chapter 9.Spills and Accidents

Unwanted incidents such as spills, injuries, and other types of accidents can happen even in a well-managed laboratory.

1. Being Prepared For Accidents

The best strategy for dealing with accidents is to prevent them in the first place by following good housekeeping and purchasing practices and effectively training laboratory workers.

- Know where your safety equipment is
- Verify that your equipment works and supplies haven't expired
- Communicate accident/injury reporting and response protocols

A. Persons responsible for checking emergency equipment

The Supervisor is responsible for checking that emergency eye washes work, fire extinguishers (if issued) are in position, and that spill kits or first aid kits have the necessary supplies.

It is good practice to check emergency equipment, fume hoods, and other safety equipment BEFORE starting any hazardous work.

Official monthly checks of fire extinguishers and eye washes and other building safety systems are the responsibility of the Facility Service Enterprises ("Facilities").

B. Report injuries

Report both minor and serious injuries to the lab Supervisor promptly. If the injury is severe, the person has fainted, or you aren't sure if it is major or minor, contact University Police at 415.338.2222 or dial 911 from any campus telephone.

Injury or incident follow-up and reporting is covered in more detail in the SFSU Injury & ***Illness Prevention Program*** (IIPP).

C. Preventing accident risks

Training laboratory workers in safe work practices and in emergency procedures is critical to protecting their safety and health.

All people working in a lab should know who to call, when to call, when to evacuate, where to find emergency equipment, and how to safely shut down equipment and ongoing experiments.

Provide new hires with a documented safety orientation before they start unsupervised work and at least within 30 days of starting work. This is job-specific training and should include the following information:

- Importance of washing hands, wiping bottles, and decontaminating surfaces;
- When gloves, eye protection, and lab coats should be worn;
- Which chemicals can be stored together;
- How to safely handle glassware, syringes, and other equipment;
- Recognizing the signs and symptoms of overexposure.
- How to contain and clean up minor spills.

D. How to react during an Emergency

The most important thing to do is to avoid panic. Remain calm and assess the problem. Call for help when necessary and don't put yourself in danger. For details about handling different emergencies, see the COSE's Emergency & Evacuation Plan

E. Some guidelines for responding to emergencies

If in doubt, call 911 from any campus telephone. For cell phone users, call 415.338.2222 for the University Police Dispatcher.

Figure 9.1

Nature of Emergency	**Recommended Action**
Small (Incipient) Fire	Incipient fires are those that just started and are localized, i.e., in a trash can or sink. ◂ For small fires in the incipient stage, you may use a fire extinguisher to put it out. ◂ Break the small plastic seal on the handle. Remember to point the nozzle at the base of the fire and sweep back and forth**. Do not put yourself in danger!**
Spreading Fire	◂ Evacuate the room and close the door. Do not attempt to fight it. ◂ Pull the fire alarm or call 911
Evacuation Alarm Sounds	Leave the building using the nearest safe stairwell and wait outside until the building is cleared for re-entry by police or evacuation team.

Injury or Loss of Consciousness	If first aid is not feasible or you're unsure, call 911. Campus Police has officers trained in first aid and CPR and will provide assistance.
Small Chemical Spill	◂ If the spill is small and you know how to clean it up, do so promptly. ◂ If unsure contact the PI or Stockroom. ◂ Wear protective equipment (i.e. gloves) and avoid breathing vapors from the spilled material. ◂ Use appropriate material or sorbent to neutralize and absorb inorganic bases and acids or other chemicals. ◂ Collect residue into a container and dispose as chemical waste.
Uncontrolled Chemical Reactions	◂ Leave the area promptly and close the door ◂ Call 911. ◂ Alert the stockroom and nearby labs ◂ If you believe there is a serious and immediate danger to others, pull the fire alarm in the main hallway to evacuate the building.
Chemical Splash on Face	◂ Take person to the nearest emergency eye wash. ◂ Flood affected area for at least 15 minutes or longer if pain persists. (Don't use creams, lotions, or salves – leave that for medical personnel) ◂ Don't worry about making a mess. ◂ Take person to Student Health Center AFTER flushing the affected area if he/she is able to walk. Call 911 if the injury is too serious to move the victim. ◂ Ask someone to alert the stockroom and faculty in charge
Chemical Splash on Body	◂ Take person(s) from spill area to nearest emergency shower. ◂ Remove contaminated clothing while victim is under the shower. Use a towel or coat to shield the person from view. ◂ Flood affected area for at least 15 minutes or longer if pain persists. (Don't use creams, lotions, or salves – leave that for medical personnel) ◂ Don't worry about making a mess.

- Take person to Student Health Center AFTER flushing the affected area if he/she is able to walk. Call 911 if the injury is too serious to move the victim.
- Ask someone to alert the stockroom and faculty in charge

2. Responding to Chemical Spills and Releases

The complete Spill Response Plan for the sciences is available on the SFSU website for review. The section reviews the plan for incidental spills in laboratories.

A. Incidental Spills - Small, Low-Toxicity Chemical Spills

Laboratory workers must receive training to distinguish between the types of spills they can handle on their own and those spills that are classified as "Minor/Medium and "Major".
Laboratory workers are qualified to clean-up spills that are "incidental". OSHA defines an incidental spill as a spill that does not pose a significant safety or health hazard to employees in the immediate vicinity nor does it have the potential to become an emergency within a short time frame. The period that constitutes a short time is not defined.

Laboratory workers can handle incidental spills because they are expected to be familiar with the hazards of the chemicals they routinely handle during an "average" workday. If the spill exceeds the scope of the laboratory workers' experience, training or willingness to respond, the workers must be able to determine that the spill cannot be dealt with internally. Training in spill response is required for all laboratory workers in *hazmat* labs.

1. An incidental spill may be cleaned up by lab workers under these criteria:

- Four liters or less of material with low to medium toxicity and pH > 2.0 and < 10.0
- One liter or less of higher toxicity or corrosive liquids with a pH of < 2.0 or > 10.0
- Small enough that you have enough clean up supplies in your lab to deal with the spill
- Something you feel comfortable cleaning up.
- Material spilled is yours and you know what it is*

B. General SOP: Incident Spill Cleanup

- Notify lab or shop personnel and neighbors of the accident.
- Isolate the area by closing lab or shop doors. Post a sign if it will take a while.
- Locate spill kit and choose appropriate PPE.
- Confine and contain the spill with appropriate absorbent material.
- Open windows and fume hood sashes to increase ventilation in the area
- Gently sweep solid material into a plastic dustpan and place in a sealed container. (Avoid generating dust. Consider carefully placing a damp paper towel over powders.)
- Put all contaminated items (gloves, clothing, etc.) into a sealed container or plastic bag.
- Label container with "waste ID tags".
- Fill out in incident report, have it signed by the lab/shop/supervisor and submit it to EH&S at sfehs@sfsu.edu.

* Hazardous materials spilled outside of your work area and don't belong to your group should be cleaned up only by designated personnel with documented OSHA HAZWOPER training or directly under their supervision.

Each laboratory is required to have a spill kit suitable for the type of hazardous materials used or stored in the space. The PI or Lab Manager is responsible for keeping the kit stocked and available for use in the lab. Instruction videos for how to use the kits for different types of spills are available on the SFSU EHS website.

C. General SOP: Responding to Major Spills or Releases

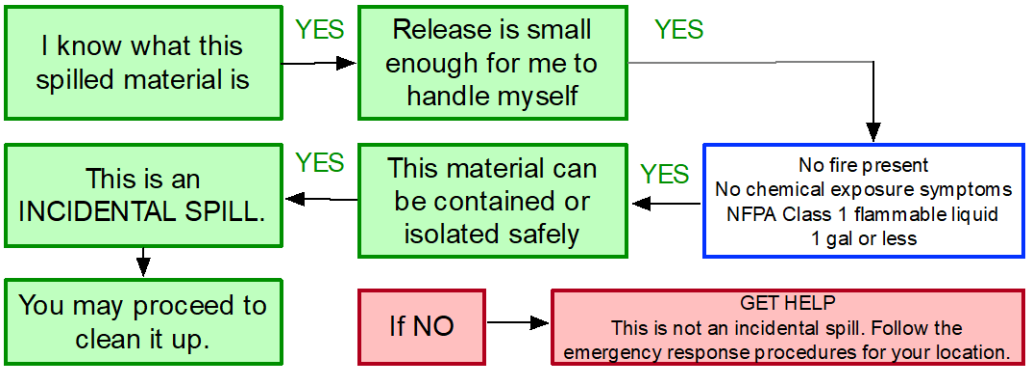
For the purposes of this CHP, a major spill or release will include any spill too large or hazardous for lab personnel to clean up. Also included are spills of unknown material or that do not belong to the lab or part of their research or project.

In the event of a chemical spill which: 1) involves the release of a type or quantity of a chemical that poses an immediate risk to life and health; or 2) involves an uncontrolled fire or explosion, DO NOT ATTEMPT TO CLEAN IT UP!

1. If possible and safe to do so, turn off equipment and shut down active experiments.
2. Close the doors and inform people in the area of the spill and potential hazard
3. If threat is localized, post a sign on the door or in the area
4. Notify your supervisor and/or your stockroom staff, whichever is quickest.
5. If the threat is large scale or threatens to spread beyond the immediate area, evacuate the building by pulling the nearest fire alarm.

6. Call the University Police Dept to start the emergency response process

Figure 9.2



Chapter 10. Chemical Waste Disposal

Chemical waste, termed “hazardous waste”, is regulated by the U.S. Environmental Protection Agency (EPA) and the California Department of Toxic Substance Control (DTSC). Other regulated waste such as biohazardous and radiological waste are not referred to as “hazardous waste” and must be handled and stored in accordance with different regulations.

These other types of regulated waste must be kept separate from hazardous waste and do not belong in the 90-day hazardous waste collection shed/area:

- Sharps (no chemical contamination)
- Broken glass (clean or uncontaminated)
- Solid non-hazardous waste (trash)
- Biohazardous or medical waste
- Radioactive waste

Hazardous Waste refers to chemicals that are expired, unwanted, no longer useful, or "waste-like"*, as well as substances and materials that are contaminated with chemicals that are 'listed' as hazardous by regulations or otherwise harmful to humans or to the environment.

- A chemical/material does not become "waste" until the generator designates it as waste.
- EH&S, Operational Staff, or Regulators may make the determination based on their knowledge and experience if they conclude an unmarked material appears “waste-like”*.
- Waste containers are no longer "inventory" and are under hazardous waste regulations.

***Waste-like** is a material that, although not marked as "waste", a knowledgeable person could reasonably conclude it is a waste (i.e., EH&S staff, regulators, etc.). Below are examples of items that are inherently waste-like:

- it looks like trash
- material has reacted or degraded
- appears unclaimed or forgotten
- container is damaged or leaking
- spilled materials
- used spill cleanup supplies

1. Managing Hazardous Waste

A facility that generates hazardous waste in the state of California, must comply not only with the California hazardous waste regulations, but also with federal regulations that have not yet been incorporated into the California rules.

A. General SOP: Managing Hazardous Waste

1. Collect hazardous waste in containers that are in good condition and compatible with the waste.
2. Affix a Hazardous Waste I.D. tag to all hazardous waste containers that is visible and contains the required information.
3. Use ballpoint or indelible ink on hazardous waste tags (so they are always legible) and include all required information.
4. Hazardous waste containers must remain closed, except when adding or removing waste, or if venting is necessary for safety reasons.
   - If you are using a funnel use the self-closing type or replace the cap each time you are finished adding waste.
   - If collection container must be vented, minimize the size of the opening.
5. Segregate incompatible wastes (to prevent a fire or explosion, or other unsafe condition).
6. Ensure all personnel know that chemicals may NEVER be disposed of down the drain, evaporated into the atmosphere, or thrown in the general trash!
7. Treat empty chemical containers as hazardous waste, unless they are completely empty (i.e., the contents have been completely scraped out if a solid, or all liquid has been poured and not a single drop is generated when held upside-down.)
8. Labs that generate hazardous waste and stockrooms must be equipped with spill kits.
9. Ensure hazardous waste collection containers are obviously separated from in-use chemical containers to avoid confusion and mistakes.

B. Receipt of Waste by Stockroom

Stockroom/ Support/EH&S staff is not responsible for identifying and labeling waste from other generators. Hazardous waste with missing/incomplete waste ID tags, in degraded or damaged containers, or that appear unstable, will not be accepted. Stockroom staff are responsible for checking waste containers before placing them into the 90-day central hazardous waste collection area/shed.

- Verify that all waste containers have a completed waste ID tag.
- Check all waste containers for spillage or container degradation before transferring to the 90-day area.
- Transfer waste to the 90-day area the same day. No overnight or unattended storage of waste from other generators is permitted in stockroom areas.

90-Day Hazardous Waste Central Collection Area

Only authorized personnel may enter the restricted 90-day hazardous waste collection areas.

- No biological or radioactive waste may be stored in the 90-day waste collection area.
- Clear aisle space (at least 30 inches) must be available between rows of waste carts so that all waste labels can be visible and containers can be accessed.
- No waste may be stored on the floor.
- Waste containers should be in a stable position to avoid falling off the carts or shelves
- Maximize storage space by placing containers in carts/shelves starting from the back

C. Transferring Waste to a New Location

Transferring or moving waste must be done in a manner that minimizes the potential for spills and damaged containers. Appropriate equipment and training of personnel is required.

- Transport* or carry waste in bottle holders or sturdy carts
- Overpack damaged or leaking containers
- Use the freight elevator whenever possible
- Do not use a passenger elevator if there are multiple occupants
- Make sure the destination is prepared to accept the waste

Definition:
Transport- To carry from one place to another on campus, not on public roads.

Overpack- To transfer original container into a larger, sturdier, or undamaged container.

D. Satellite Accumulation Areas for Hazardous Waste

The standard hazardous waste storage time is 3 days before a waste container must be transferred to the 90-day central storage area awaiting pickup for disposal.

Example: You discover a bottle of methanol has expired or decide it is no longer needed. You now have 3 days to transfer it to the hazardous waste shed.

A special exemption applies to hazardous waste that is accumulated at an initial point or at a laboratory accumulation area near the site of generation. This includes a longer accumulation time and relaxed storage, inspection, and training requirements.

Note: A full waste collection container has, by definition, finished accumulating waste.

General SOP: Satellite Accumulation Area for Hazardous Waste

1. Designate a waste collection area so that inventory or in-use materials are segregated.
2. Use secondary containers or trays to store waste
3. Keep waste containers closed when not adding waste.
4. Separate waste chemicals by hazard class (see Key Incompatible Wastes).
5. Remove accumulation containers when full or when the 10-month time limit has been reached. Contact stockroom or designated support staff for waste disposal.
6. Attach a waste ID tag to each container that includes the following *legible* information:
   - start date
   - generator information
   - waste description
   - hazardous properties
   - physical state
   - the words, "**hazardous waste**"

a. ACUTELY and EXTREMELY Hazardous Waste

Acutely and extremely hazardous wastes are waste that would cause death, disabling personal injury, or serious illness. These wastes are more hazardous than ordinary hazardous wastes.

Examples: Potassium cyanide, sodium azide, sodium cyanide

Accumulation limits and times are more restrictive than standard hazardous waste: There is a 1quart accumulation limit for liquids and 1 kilogram for solids.

b. Laboratory Satellite Accumulation of Hazardous Waste

In California, hazardous waste accumulated in laboratories is governed by Health and Safety Code (HSC) Section 25200.3.1. At SFSU, laboratory satellite accumulation is handled under the standard accumulation regulation and requirements as listed in the SOP above. Any differences in practices, from the above SOP, that are allowed by this HSC for laboratories require the approval of the EH&S Environmental Manager.

At SFSU, the maximum time a waste may "accumulate" in a container is 10 months from the day the first drop or piece of waste entered the container.

E. Hazardous Waste Management Practices for Lab Managers

Lab Managers, including Principal Investigators and Staff Supervisors, are responsible for making sure hazardous waste is being tagged, stored, and handled correctly.

1. Inspect waste storage areas regularly to ensure the rules are being followed (Principal Investigators, Staff Supervisors, and Lab Managers).
2. Make sure each hazardous waste tag accurately reflects what is in the container.
3. Train all personnel in the laboratory on the waste storage, handling, and labeling rules.
4. Check that spills are cleaned promptly and that labels and tags are legible.
5. Check that both dry and liquid waste collection containers are kept closed when not actively being used.
6. Ensure that personnel do not mix waste streams unless you know they are compatible.
7. Do not store waste any longer than necessary. Promptly remove waste container when experiment is finished or when full.
8. Do not allow dry waste to overfill the collection container or to be without a properly filled out hazardous waste ID tag

9. Do not allow evaporation of hazardous waste (or chemical containers) to treat or reduce volume or waste generated.

Poor waste management practices reflect on the PI or lab manager.

Examples: Waste container sitting in a fume hood for 18 months, incomplete or missing hazwaste ID tags, overflowing waste containers, no lid or cap on waste collection container even when lab is unoccupied.

Major Classes of Incompatible Waste

As a general safety practice, do not combine these waste types in the same collection container or same secondary containment tray or vessel. Unexpected reactions can injure the people handling the containers or cause potentially serious safety issues during waste packaging and transportation.

strong acids and strong bases	water reactives and aqueous solutions	mineral acids and organic acids
acids and metals	organic solvents and inorganic acids	organic solvents and oxidizers
acids and cyanides	non-halogenated and halogenated solvents*	nitric acid and organics

**not compatible at the disposal end*

F. The importance of correctly labeling waste

By law and in order to be safely handled by hazardous waste workers, the information on the tag must be accurate. Also, knowing what is in the waste container is essential for correct packaging and disposal.

2. Minimizing Laboratory Waste

Minimizing the amount and reducing the hazardous properties of laboratory waste is good practice and provides waste disposal savings.

A. Reduce quantities of hazardous waste

(1) Automation/ Instrumentation

- Purchase equipment that enables the use of procedures that produce less waste.

(2) Reduce scale

- Scale down experiments producing hazardous waste wherever possible

(3) Microscaling (in teaching laboratories)

- Consider use of microscale experiments. Consider demonstrations or video presentations as a substitute for some student experiments that generate chemical wastes.

(4) Conservation of raw materials

- When solvent is used for cleaning purposes, use spent solvent for initial cleaning and fresh solvent for final cleaning.

(5) Perform work in batches

(6) Reusing material (after processing, if needed), in original process or reclamation for use in other processes

B. Reduce the hazardous properties of lab waste

Substitution of less hazardous chemicals and protocols can reduce the level of hazard in the waste the COSE generates.

For example, replacing acetone for cleaning surfaces with cleaning detergents, and macromolecule

C. Prove a lab waste is "non-hazardous" for disposal purposes

Justify and document the reasoning for declaring a lab waste as "non-hazardous". The term "hazardous waste" has legal implications requiring knowledgeable disposal practices. EPA, Cal-EPA, county health, water treatment district and the fire department all regulate waste to some extent. As the generator of the waste, you must be able to justify your collection and disposal protocols.

If you think a waste stream you generate isn't hazardous, obtain a "Petition for Non-Hazardous Waste Status" from the EHS Liaison to COSE. You'll have to describe your process for generating the waste and note the concentration of each material in your waste stream.

Upon receipt, University EHS will evaluate your request and let you know if it is okay to change your disposal practice.

For more details on the University hazardous waste management programs, see the Environmental page on the EH&S website or contact the Environmental Compliance Manager in EH&S.

Appendix A—Document Review and Amendment Log

Date	Amendments	Pages/Sections	Initials
Nov. 2019	Completely Revised CHP was developed by EH&S	All sections	MM LEV
Jun. 16, 2021	Renumbered the pages so the numbers are consecutive instead of separated by chapters.	All pages	LEV
Jun. 30, 2021	Removed obsolete COSE organization chart	Page 3	LEV
Jun. 30, 2021	Added the phrase "pending approval" to the procedure to pre-approve the use of particularly hazardous substances or University restricted chemicals. Procedure is not yet implemented due to COVID-related delays	Appendix B-4	LEV
Sep. 12, 2022	Improved accessibility for publishing online – alternate text for graphics, etc.. Added links to the restricted chemicals and equipment page on the EHS website	Whole document	LEV
July 10, 2023	Corrected CHP reference chapters in table to reflect current location of content.	Overview, Page 1 and 2 Sections (A)(D)(F)(H)	LEV
July 10, 2023	Updated training titles in second General Lab Safety row to reflect current titles. Responsible Persons may report new lab members directly to EH&S (instead of only going through department safety coordinator) Removed the reference to the "burgundy" binder for departments to maintain, as this is no longer needed. The documents are now online on the EHS Website.	Chapter 1, Page 11 Page 15, Section B Page 15, Section C	LEV
July 10, 2023	Modified Signs and Labels chapter Reworded Section A.1 reviewing OSHA and ANSI signal words and when to use them. Added a text noting that GHS hazard categories are rated the opposite from NFPA and HMIS.	Chapter 4, Page 56 Page 57,	LEV

Appendix B—Particularly Hazardous Substances (PHS)

Appendix B covers the use of *Particularly Hazardous Substances*, as described by the Lab Standard for health hazards and other *Restricted Chemicals* as designated by the campus that address serious potential physical or regulatory hazards.

The Lab Standard requires provisions for additional employee protection for work with particularly hazardous substances (PHS) that include the following types:

- select carcinogens
- reproductive toxins
- substances which have a high degree of acute toxicity.

List of Contents

Substance Name	PHS or Restricted	Note
Acetaldehyde	PHS	
Acrylamide	PHS	
Acrylonitrile	PHS	
Hydrofluoric acid	Restricted	
Methylene chloride	PHS	
Osmium tetroxide	PHS	
>70% Hydrogen Peroxide	Restricted	
Sodium cyanoborohydride	PHS	
Uranyl acetate	Restricted	

Appendix B.1

Selected Terminology

Exposure to harmful chemicals can result in local toxic effects, systemic toxic effects, or both. Some terms are critical to understanding health effects and information from documents such as Safety Data Sheets.

Local Effects Injury at the site of first contact, for example skin, nose, and respiratory tract.
Systemic effects Can occur after the substance has been absorbed into the bloodstream and distributed throughout the body.
Acute exposure A local or systemic effect from a single exposure
Chronic exposure Repeated or long-duration exposures
Irritant Non-corrosive chemical that causes reversible inflammatory effects (redness and swelling) on living tissue by chemical action at the site of contact.
Corrosive Chemical that causes destruction of living tissue by chemical action at the site of contact. These can be solids, liquids, or gases.
Allergen A chemical that causes an adverse reaction by the immune system to a chemical resulting from a previous sensitization to that chemical or a structurally similar chemical. Once sensitization occurs, allergic reactions can result from exposure to extremely low doses of the chemical. Symptoms often include red, itchy, swollen skin or eyes, or difficulty breathing.
Asphyxiant A chemical that interferes with the transport of oxygen to the vital organs of the body leading to rapid collapse and death. Some asphyxiants simply displace oxygen in the air while others interact with hemoglobin in the blood to reduce the capacity of blood to carry oxygen.
Neurotoxin A chemical that adversely affects the structure or function of the central and/or peripheral nervous system. Effects can be reversible or permanent. Confusion, slurred speech, and staggered gait are common symptoms of overexposure.
Target Organ Toxin: Chemical that causes adverse effects to organs other than the reproductive or neurological systems. These organs typically include the liver, kidneys, blood producing organs, and lungs.
Peroxide-Forming Substances Chemicals that form explosive levels of peroxides even if not opened. (Divided into three categories or groups). *Group A*: Isopropyl ether, Sodium amide *Group B*: Tetrahydrofuran, Diethyl ether *Group C*: Acrylonitrile, Vinyl acetate

Appendix B.2

Note 1 The list below does not include every substance that meets these criteria. Review the Safety Data Sheets before using substances that may be particularly hazardous due to toxicity or reactivity.

Examples of Particularly Hazardous Substances

Select Carcinogens

A chemical that is capable of causing cancer, or the uncontrolled growth of cells. Often there is no immediately apparent harmful effect upon exposure.

Chemicals that are known to pose the greatest carcinogenic hazard are referred to as "select carcinogens" and must be handled as "particularly hazardous substances". A select carcinogen is defined in the OSHA Laboratory Standard as a substance that meets one of the following criteria.

1. It is regulated by OSHA as a carcinogen in 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances.
2. It is listed as "known to be a carcinogen" in the latest Annual Report on Carcinogens issued by the National Toxicology Program.
3. International Agency for Research on Cancer (IARC), "Monographs"
   - Group 1 – carcinogenic to humans
   - Group 2A – probably carcinogenic to humans
   - Group 2B – possibly carcinogenic to humans
   - Reasonably anticipated to be a carcinogen by the National Toxicology Program AND causes statistically significant tumor incidence in experimental animals.

2-Acetylaminofluorene
Acrylamide
Acrylonitrile
Aflatoxins
4-Aminobiphenyl
Arsenic (and certain arsenic compounds)
Asbestos
Azathioprine
Barium chromate
Benzene
Benzidine
Bis(chloromethyl) ether
Chloroemthyl methyl ether
1,4-Butanediol dimethylsulfonate
Chlorambucil
Chromium (and compounds)
Cyclophosphamide
1,2-Dibromo-3-chloropropane
3,3'-Dichlorobenzidine (and its salts)
Diethylstilbestrol
4-Dimethylaminoazobenzene
Dimethyl sulfate
Ethylene dibromide
Ethylene oxide
Ehtylenamine
Formaldehyde
Hexamethylphosphoramide
Hydrazine
Melphalan
4,4'-Methylene-bis[2-chloroaniline]Mustard gas
N,N-Bis(2-chloroehtyl)-2-naphthylamine
Nampthylamine (α and β)
Nickel carbonyl
4-Nitrobiphenyl
N-Nitrosodimethylamine
β-Propiolactone
Thorium dioxide
Treosulfan
Vinyl chloride

Reproductive Toxins

A chemical that affects reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis)

Arsenic (and certain of its compounds)
Benzene
Carbon disulfide
Cadmium (and certain compounds)
Toluene
Xylene
Ethidium bromide
Ethylene glycol monomethyl
Ethyl ethers
Ethylene oxide
Ethylene dibromide
Lead compounds
Vinyl chloride

High Level Acute Toxins

Chemicals that can cause extremely harmful effects after a single exposure. "Prudent Practices in the Laboratory" indicates that substances with a toxicity rating of "highly toxic" or "extremely toxic", based on an animal oral LD_{50} of 50 mg per kg (or less), are considered to have a high level of acute toxicity.
(See Table 3.2 on page 42 of Prudent Practices for details.)

Acrolein
Arsine
Chlorine
Diazomethane
Diborane (gas)
Hydrogen cyanide
Hydrogen fluoride/hydrofluoric acid
Methyl fluorosulfonate
Nickel carbonyl
Nitrogen dioxide
Osmium tetroxide
Ozone
Phosgene
Sodium azide
Sodium cyanide (and other cyanide salts)

Chemicals Restricted by Policy at SFSU

Extreme Physical Hazard Substances that pose a physical hazard to users due to instability, extreme reactivity or flammability, or form peroxides and other hazardous degradation products or pose a storage or infrastructure problem.	>70% Hydrogen Peroxide 90%-100% Hydrogen gas Ethylene oxide gas	Ethyl ether Tetrahydrofuran Sodium or potassium amide
Special Hazard / Expensive Storage or Disposal Substances that are very expensive or difficult to dispose of due to physical properties or regulatory restrictions.	Uranyl acetate	Hydrofluoric acid

Appendix B.3

Particularly Hazardous Substance Use Form

Before using any particularly hazardous substance or restricted chemical, please complete this form and have it approved by your PI or Chemical Hygiene Officer. See the back of this form for more complete definitions of a particularly hazardous substances and instructions for completing this form.

Your Name _____ Telephone: _____ Email: _____

Supervisor: _____ Location: _____ (Bldg and Room) Lab Group: _____

1. Substance Information

A. Substance Name _____ CAS Number _____

B. Hazard Category ☐ Carcinogen ☐ High Acute Toxicity ☐ Reproductive Toxin ☐ Flammable Gas ☐ Toxic Gas ☐ Reproductive Toxin ☐ Physical or Reactive Hazard

C. Estimated Rate of Use (i.e., grams or mL per month) _____

D. SDS reviewed and readily available. ☐ YES ☐ No

E. Purpose of Substance _____

_____

2. Special Hazards

A. Physical Hazards (GHS/HazCom Appendix B Class 1 Hazard Class)

☐ Extremely Flammable (Class 1) ☐ Pyrophoric/Air Reactive ☐ Extremely Water Reactive
☐ Temperature Sensitive ☐ Forms Peroxides ☐ Pressure or Shock Sensitive
☐ Unstable (i.e., decomposes into hazardous form, polymerizes) ☐ Explosive

Known Incompatibilities _____

B. Significant Health Hazards (GHS/HazCom Appendix A Class 1 Hazard Class)

☐ Extremely Toxic (Chronic) ☐ Respiratory Sensitizer ☐ Burns to skin or eyes upon contact
☐ Carcinogen ☐ Acutely Poisonous (Acute) ☐ Attacks organs or bones (Acute)
☐ Absorbs through intact skin or mucous membranes *Other* _____

C. Obvious Over-Exposure Symptoms

☐ Burning of skin or eyes ☐ Change in skin color ☐ Nausea
☐ Burning of throat ☐ Dizziness/Confusion ☐ Coughing/Breathing Trouble
Other: _____

D. Special First Aid/Neutralization/Decontamination

☐ Antidote _____ ☐ Other _____

3. Exposure Controls

A. Ventilation/Isolation

☐ Chemical Fume Hood Required ☐ Vented Gas Cabinet Required
☐ Glove Box Required ☐ Separate Room w/its Own Ventilation
☐ Use of Vacuum System ☐ NO ☐ YES
If YES, method of trapping effluents _____
☐ Spark Arrestor (flammables) ☐ Carbon Filter (organics)

B. Personal Protective Equipment

Eyes/Face	☐ Safety glasses w/side shields	☐ Chemical splash goggles	☐ Face shield
Body	☐ Lab Coat	☐ Apron	☐ Closed-toe shoes
Hands	☐ Disposable Nitrile (two pairs)	☐ Rubber/Neoprene	☐ PVC ☐ Viton
	☐ Disposable vinyl	☐ Specialty: _____	
Respirator	☐ Dust/Aerosol Dust Mask	☐ Air Purifying (carbon filter)	☐ Air Purifying (acid filter)
	☐ SCBA	☐ Air Purifying (HEPA filter)	☐ Air Purifying (combo filter)

5. Designated Area

A. Location of Use: _____ Area is posted ☐ NO ☐ YES Storage Location

B. Describe below the area where substance(s) will be used and the method of posting as a designated area.

_____

D. Storage Method/Precautions

☐ fume hood ☐ freezer ☐ flammable liquids cabinet
☐ double containment ☐ refrigerator ☐ corrosive liquids cabinet
☐ dessicator ☐ under vacuum ☐*other* _____

6. Spills and Decontamination

A. Spill control materials readily available ☐ NO ☐ YES
B. Special personal protective equipment needed ☐ NO ☐ YES
C. Decontamination method _____

7. Waste Disposal

A Dispose as hazardous waste ☐ Yes ☐ No

Notice: Disposal of hazardous waste using sinks, intentional evaporation, or as regular trash is against the law. Campus laboratories must abide by strict state and federal waste disposal requirements. You may be held liable for violations of applicable laws.

B. ☐ In-lab neutralization ☐ Deactivation

Neutralization or deactivation is permitted only if done as part of the use process, not as a separate "treatment" of hazardous waste.

8. Authorization

This individual has demonstrated an understanding of the hazards of the listed substance and plans to handle the substance in a manner that minimizes risk to health and property. He/she is authorized to use the substance in the manner described.

_____ _____
Principal Investigator/Supervisor Signature of Authorized User

Appendix B.4

Guide for Working with PHS or Restricted Chemicals

OSHA's Laboratory Standard states that the employer must make "provisions for additional employee protection for work with particularly hazardous substances" such as the following:

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

EH&S has developed SOPs addressing these provision requirements for a select number of 'high level' acute toxins", reproductive toxins, and 'select' carcinogens. Please contact the office at x8-6892 for more information on what is available.

Approval Procedure - Pending final approval

Laboratory workers planning to use a particularly hazardous substance (PHS) must first receive explicit written approval from their Principal Investigator and/or Chemical Hygiene Officer. The following steps must be taken:

1. Laboratory workers must complete a Particularly Hazardous Substance Use Approval form. Information required on the form includes:
   - Identity, physical characteristics, and health hazards of the substances involved
   - Consideration of exposure controls such as fume hoods, glove boxes and personal protective equipment
   - Designation of an area (hood, glove box, portion of lab, entire lab) specifically for experimental procedures with the substances involved
   - Plans for storage and secondary containment
   - Procedures for safe removal of contaminated waste
   - Decontamination procedures

2. The laboratory worker submits the form to the Principal Investigator and receives approval.

3. The area where the PHS will be used is posted as a designated area. Signs for this purpose are available through the COSE Health and Safety Office or may be made by the department or laboratory worker, as long as it includes the following information:

DANGER DESIGNATED AREA for select carcinogens, reproductive toxins and high acute toxicity chemicals AUTHORIZED PERSONNEL ONLY

4. The laboratory worker proceeds with the experiment, following the practices outlined in the Particularly Hazardous Substance Use Approval form, as well as the appropriate work practices included in the remainder of the Safe Work Practices and Procedures section of this manual. All work is conducted within the Designated Area.

5. The laboratory worker decontaminates all equipment and disposes of waste promptly, as outlined in the Particularly Hazardous Substance Use Approval form.

Working Safely with Particularly Hazardous Substances

The increased hazard risk associated with Particularly Hazardous Substances (PHS) calls for more strict operating procedures in the laboratory:

Work Habits

- There should be no eating, drinking, smoking, chewing of gum or tobacco, application of cosmetics or storage of utensils, food or food containers in laboratory areas where PHS are used or stored.
- All personnel should wash their hands and arms immediately after the completion of any procedure in which a PHS has been used and when they leave the laboratory.
- Each procedure should be conducted with the minimum amount of the substance, consistent with the requirements of the work.
- The laboratory worker should keep records of the amounts of each highly hazardous material used, the dates of use and the names of the users.
- Work surfaces, including fume hoods, should be fitted with a removable liner of absorbent plastic-backed paper to help contain spilled materials and to simplify subsequent cleanup and disposal.

Personal Protective Equipment

PHS may require more stringent use of personal protective equipment. Check the SDS for information on proper gloves, lab clothing and respiratory protection.

- Proper personal protective equipment must be worn at all times when handling PHS.
- Lab clothing that protects street clothing, such as a fully fastened lab coat or a disposable jumpsuit, should be worn when PHS are being used. Laboratory clothing used while manipulating PHS should not be worn outside the laboratory area.
- When methods for decontaminating clothing are unknown or not applicable, disposable protective clothing should be worn. Disposable gloves should be discarded after each use and immediately after overt contact with a PHS.

Ventilation/Isolation

Most PHS work should be performed in a fume hood, glove box, or other form of ventilation. If the chemical may produce vapors, mists or fumes, or if the procedure may cause generation of aerosols, use of a fume hood is required.

A fume hood used for PHS must have an average face velocity of at least 100 feet per minute. This measurement is noted on the hood survey sticker. If the hood has not been inspected within the past year, report this to your stockroom and wait for re-inspection before using the hood.

A glove box should be used if protection from atmospheric moisture or oxygen is needed or when a fume hood may not provide adequate protection from exposure to the substance; e.g., a protection factor of 10,000 or more is needed.

Highly toxic gases must be used and stored in a vented gas cabinet connected to a laboratory exhaust system. Gas feed lines operating above atmospheric pressure must use coaxial tubing.

Storage and Transportation

Stock quantities of PHS should be stored in a designated storage area or cabinet with limited access. Additional storage precautions (i.e., a refrigerator, a hood, a flammable liquid storage cabinet) may be required for certain compounds based upon other properties.

Containers must be clearly labeled.

Double containment should also be considered. Double containment means that the container will be placed inside another container that is capable of holding the contents in the event of a leak and provides a protective outer covering in the event of contamination of the primary container.

Containers should be stored on trays or pans made of polyethylene or other chemically resistant material.

Persons transporting PHS from one location to another should use double containment to protect against spills and breakage.

Vacuum Lines and Services

- Each vacuum service, including water aspirators, should be protected with an absorbent or liquid trap to prevent entry of any PHS into the system.
- When using volatile PHS, a separate vacuum pump should be used. The procedure should be performed inside a fume hood.

Decontamination and Disposal

- Contaminated materials should either be decontaminated by procedures that decompose the PHS to produce a safe product or be removed for subsequent disposal.
- All work surfaces must be decontaminated at the end of the procedure or work day, whichever is sooner.
- Prior to the start of any laboratory activity involving a PHS, plans for the handling and ultimate disposal of contaminated wastes and surplus amounts of the PHS should be completed. EH&S can assist in selecting the best methods available for disposal.