Chemical Hygiene Plan

SOUTHERN CALIFORNIA UNIVERSITY OF HEALTH SCIENCES

Revised 11/10/2018

Safety and Compliance Committee

Department of Industrial Relations
STATE OF CALIFORNIA

State of California
CAL OSHA
Department of Industrial Relations

This is the Chemical Hygiene Plan specific to the following areas:

Building(s)/Room Number(s): I Bldg Lab, J Bldg Lab, L-90, L-120, E-80, E-120, M-90, University Health Center,

Chemical Hygiene Officer: AVP for Auxiliary Operations

Laboratory Supervisor: Chief Laboratory Technician (see Appendix A for Job Description)

Department(s): College of Science & Integrated Health, Los Angeles College of Chiropractic, College of Eastern Medicine, University Health System, and Auxiliary Operations and Physical Plant

Revised *(Must be reviewed at least annually by Safety and Compliance Committee)*: 7/2/2014

Important Telephone Numbers:

1. 911 for All Emergencies
2. Local Fire Department – Station 15 – (562)943-4537 (Non-Emergency Line)
3. Local Police Department – Norwalk Sheriff – (562)863-8711 (Non-Emergency Line)
4. SCU Campus Safety Department – (562)902-3333 (Do Not Use for an Emergency)
5. SCU Auxiliary Operations & Physical Plant – (562)947-8755x515 (Do Not Use for an Emergency)

All laboratory chemical use areas must maintain a work-area specific Chemical Hygiene Plan which conforms to the requirements of the OSHA Occupational Exposure to Hazardous Chemicals in Laboratories (29 CFR 1910.1450). SCU laboratories may use this document as a starting point for creating their work area specific Chemical Hygiene Plan. Minimally, this cover page is to be edited for work area specificity and the SCU Chemical Hygiene Plan Awareness Certification Form must be completed for all lab employees. This instruction and information text should remain. This model Chemical Hygiene Plan is the 2014 version.

Appendices

CHP Document Acronyms List

ANSI- American National Standards Institute
AOPP-Auxiliary Operations & Physical Plant
ASTM- American Society of Testing and Materials
CFR -Code of Federal Regulations
CHO -Chemical Hygiene Officer
CHP -Chemical Hygiene Plan
CHiPs – Chemical Hygiene Implementation Committee
CLSC -Chemical and Laboratory Safety Committee
DOT -Department of Transportation
EHS- Environmental Health and Safety
EPA- Environmental Protection Agency
GFCI- Ground Fault Circuit Interrupter
GHS -Globally Harmonized System of Classification and Labeling of Chemicals
HBr- Hydrogen Bromide
HF -Hydrofluoric Acid
HEPA- High-Efficiency Particulate Air
HPLC -High Performance Liquid Chromatography
LC- Liquid Chromatography
LC50 -Lethal Concentration 50%
LD50 -Lethal Dose 50%
LEL- Lower Explosive Limit
LSC- Laser Safety Committee
MSDS -Material Safety Data Sheet
NFPA- National Fire Protection Association
OSHA- Occupational Safety and Health Administration
PCB- Polychlorinated Biphenyl
PHS- Particularly Hazardous Substance
PI -Principal Investigator
PPE -Personal Protective Equipment
RCRA- Resource Conservation and Recovery Act
rDNA Recombinant Deoxyribonucleic Acid
REM- Radiological and Environmental Management
RSC- Radiation Safety Committee
SAA- Satellite Accumulation Area
SACC – Safety and Compliance Committee
SDS -Safety Data Sheet
SOP- Standard Operating Procedure
UEL- Upper Explosive limit

1. INTRODUCTION

Laboratory safety is an integral part of laboratory research and is essential to ensure that Southern California University of Health Sciences (SCU's) compliance with all applicable environmental, health and safety laws, regulations and requirements are met. The risks associated with laboratory research (workplace injuries, environmental incidents, and property losses or damage) are greatly reduced or eliminated when proper precautions and practices are observed in the laboratory. To better manage and mitigate these risks, SCU has developed this Chemical Hygiene Plan (CHP), which is intended to be the cornerstone of our laboratory safety program and is designed to aid faculty, staff, and students in maintaining a safe environment in which to teach and conduct research. Each laboratory using hazardous materials is required to have a copy of the CHP readily available to all laboratory personnel. Each laboratory worker (including instructors, assistants, technicians, etc.) must be familiar with the contents of the CHP and the procedures for obtaining additional safety information needed to perform their duties safely. Not seeking further guidance concerning issues of safety is not an acceptable or recognized excuse.

1.1 PURPOSE

SCU is committed to providing a healthy and safe work environment for the campus community. The SCU CHP establishes a formal written program for protecting laboratory personnel against health and safety hazards associated with exposure to hazardous chemicals and must be made available to all employees working with hazardous chemicals in a laboratory setting. The CHP describes the proper use and handling procedures to be followed by faculty, staff, and all other personnel working with hazardous chemicals in laboratory settings.

1.2 SCOPE

The CHP applies to all laboratories that use, store, or handle hazardous chemicals and all personnel who work in these facilities. The information presented in the CHP represents best practices and provides a broad overview of the information necessary for the safe operation of laboratories that utilize hazardous chemicals. Laboratory use of hazardous chemicals is defined as handling or use of such chemicals in which all of the following conditions are met:

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

The CHP was prepared in accordance with the requirements of the Occupational Safety and Health Administration (OSHA) Occupational Exposure to Hazardous Chemicals in Laboratories Standard (Lab Standard) found in 29 CFR 1910.1450, and is based on best practices identified in, among other sources, the "Global Harmonized System of Classification and Labeling of Chemicals"; "Prudent Practices for Handling Hazardous Chemicals in Laboratories", published by the National Research Council, the American Chemistry Society Task Force on Laboratory Chemical and Waste

Management's "Laboratory Waste Management, A Guidebook"; the Princeton University "Laboratory Safety Manual"; the University of California – Los Angeles "Chemical Hygiene Plan" and the Purdue University "Chemical Hygiene Plan."

It is highly recommended that all lab workers at SCU make themselves familiar with each of the above mentioned documents.

Certain sections covered in this CHP template are not yet applicable to the type of labs currently run by SCU (i.e. those experiments involving the use of lasers, etc.); however, they are featured here in order to ensure this document covers all necessary laboratory safety regulations and can further be scaled to complement more advanced laboratories as the University continues to grow.

1.3 CHP USE INSTRUCTIONS

The information presented in the CHP represents best practices and provides a broad overview of the information necessary for the safe operation of laboratories that utilize hazardous chemicals. It is not intended to be all inclusive. Departments engaged in work with hazardous chemicals or hazardous operations that are not sufficiently covered by the CHP must customize this document by adding appropriate sections, in the form of standard operating procedures (SOPs), hazard assessments, and any other written lab-specific operating procedures that address the hazards and how to mitigate risks. The following instructions detail how this CHP template should be used and customized by each laboratory:

Review this template CHP provided by AOPP.

Send all proposed SOPs to AOPP (via campussafety@SCUHS.edu or sacc@SCUHS.edu) for review.

After review and approval, it is the lab workers responsibility to insert the lab-specific SOPs into the customized CHP under Tab 1 located in the back of the CHP document.

Insert all other documented lab-specific rules, requirements, and procedures (e.g., equipment protocols, internal lab inspections, etc.,) under Tab 2.

Insert all lab-specific hazard assessments under Tab 3. More details regarding hazard assessments can be found in Section 7.1 of the CHP.

Review, update (if necessary), and retrain all employees on the lab-specific CHP at least annually. No information may be removed from any of the manuals unless, in the opinion of the Lab Supervisor and the Chemical Hygiene Officer collectively, any of the specific practices therein might lead to an unsafe learning/working condition. Such instances should be rare – if they occur at all – and all members of SACC must be notified of the change.

1.4 EMPLOYEE RIGHTS AND RESPONSIBILITIES

As part of the OSHA Laboratory Standard, employees and other personnel who work in laboratories have the right to be informed about the potential hazards of the chemicals in their work areas and to be properly trained to work safely with these substances. This includes custodial and maintenance personnel (support staff) who work to maintain laboratories. All personnel, including principal investigators, laboratory supervisors, laboratory technicians, instructors, student workers, and support staff have a responsibility to maintain a safe work environment. All personnel working with chemicals are responsible for staying informed on the chemicals in their work areas, safe work practices and SOPs, and proper personal protective equipment (PPE) required for the safe performance of their laboratory work.

General Responsibilities for Individuals When Entering Laboratory Environment

As a general precaution any individuals entering a working laboratory (teaching, research or otherwise) that use, handle or store hazardous chemicals the following requirements, must be met*:

1. Reviewing and following requirements of the CHP and all appropriate additional laboratory Safety Manuals and Policies (if any);
2. Following all verbal and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned;
3. Following the Safety Procedures for Safe use of Pyrophoric Liquid Reagents when using butyl-lithium or as appropriate;
4. Developing good personal chemical hygiene habits, including but not limited to, keeping the work areas safe and uncluttered;
5. Planning, reviewing and understanding the hazards of materials and processes in their laboratory research or other work procedures prior to conducting work;
6. Utilizing appropriate measures to control identified hazards, including consistent and proper use of engineering controls, personal protective equipment, and administrative controls;
7. Understanding the capabilities and limitations of PPE issued to them and wearing the appropriate PPE while inside a lab environment;
8. Gaining prior approval from the PI/Laboratory Supervisor for the use of restricted chemicals and other materials;
9. Consulting with Laboratory Supervisor, Chemical Hygiene Officer, of Division/Department Chair before using particularly hazardous substances (PHS), explosives, and other highly hazardous materials or conducting certain higher risk experimental procedures;
10. Immediately reporting all accidents and unsafe conditions to the PI/Laboratory Supervisor;
11. Completing all required health, safety and environmental training and providing written documentation to their supervisor;
12. Participating in the medical surveillance program, when required
13. Informing the Laboratory Supervisor of any work modifications ordered by a physician as a result of medical surveillance, occupational injury or exposure; and when working autonomously or performing independent research or work (SCU does not encourage autonomous laboratory research – at a minimum one other trained individual should be present);
14. Reviewing the plan or scope of work for their proposed research with the Laboratory Supervisor or Division/Department Chair;
15. Notifying in writing and consulting with the Laboratory Supervisor or Division/Department Chair, in advance, if they intend to significantly deviate from previously reviewed procedures (Note: Significant change may include, but is not limited to, change in the objectives, change in the duration, quantity, frequency, temperature or location, increase or change in PPE, and

reduction or elimination of engineering controls); *SCU does not – under normal reasonable circumstances – allow for deviations of this nature except when they are linked directly to an enhanced level of personal safety.*

16. Preparing SOPs and performing literature searches relevant to safety and health that are appropriate for their work; and providing appropriate oversight, training and safety information to laboratory or other personnel they supervise or direct.

* *More stringent rules may apply to an individual based upon their role within the lab environment, see additional responsibilities provided within this chapter.*

1.5 LABORATORY SUPERVISOR RESPONSIBILITIES

The Laboratory Supervisor is the individual that is ultimately responsible for the overall laboratory operation, including the lab safety program and ensuring that the requirements of the CHP are followed by all staff members that work in the lab. For most research and teaching laboratories, the Principal Investigator (PI) is the Laboratory Supervisor. At SCU, there currently exist no programs necessitating the presence of PIs and as such, the Laboratory Supervisor function is carried out by the University's Chief Lab Technician. The Laboratory Supervisor may delegate some safety duties to qualified individuals, but ultimately remains responsible for the safety of all personnel working in the laboratory. Additionally, the Laboratory Supervisor will always serve as part of SACC and will be assisted by other members as requested. Specifically, the Laboratory Supervisor must:

1. Understand applicable environmental health and safety rules, including the contents of the CHP;
2. Identify hazardous conditions or operations in the laboratory and establish SOPs and hazard assessments to effectively control or reduce hazards;
3. Ensure that all laboratory personnel that work with hazardous chemicals receive appropriate training (refer to Chapter 9 for detailed training requirements);
4. Maintain written records of laboratory-specific training (e.g., PPE training);
5. Ensure that appropriate PPE (e.g., laboratory coats, gloves, eye protection, etc.,) and engineering control equipment (e.g., chemical fume hood) are made available, in good working order, and being used properly;
6. Conduct periodic lab inspections and immediately take steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards; and
7. Actively enforce all applicable safety procedures and ensure that the CHP is followed by lab staff and all visitors, including having a progressive disciplinary process for lab staff members that do not comply with safety rules.

The Laboratory Supervisor must ensure that employees receive CHP training and information before any work with hazardous materials occurs. Laboratory Supervisors must also ensure that all employees receive annual CHP refresher training. The Laboratory Supervisor can provide the training or delegate this task to a qualified individual (e.g., Laboratory Safety Officer, senior lab employee). The CHP training must be documented. See Appendix A for CHP Training Certification Form, which can be used to document CHP training. Failure to follow the requirements of the CHP could possibly result in injuries, fines from regulatory agencies such as OSHA, and/or disciplinary action.

1.6 LABORATORY EMPLOYEE RESPONSIBILITIES

All employees (e.g., instructors, lab technicians, graduate students, undergraduate students, post-doctoral researchers, and visiting scientists) in laboratories that use, handle, or store hazardous chemicals must:

1. Review and follow the requirements of the CHP;
2. Follow all verbal and written laboratory safety rules, regulations, and SOPs required for the tasks assigned;
3. Develop and practice good personal chemical hygiene habits such keeping work areas clean and uncluttered;
4. Plan, review, and understand the hazards of materials and processes in the laboratory prior to conducting work;
5. Utilize appropriate measures to control hazards, including consistent and proper use of engineering controls, administrative controls, and PPE;
6. Understand the capabilities and limitations of PPE;
7. Immediately report all accidents, near misses, and unsafe conditions to the laboratory supervisor; instructor, or other safety administrator;
8. Complete all required AOPP and/or other mandatory safety training and provide written documentation to the laboratory supervisor;
9. Participate in the AOPP managed medical surveillance program when required (i.e. Respirator Fit Test); and
10. Inform the Laboratory Supervisor, Chemical Hygiene Officer, or Division/Department Chair, of any work modifications ordered by a physician as a result of medical surveillance, occupational injury, or chemical exposure.

1.7 LABORATORY SAFETY OFFICER RESPONSIBILITIES

Very often it is not practical for the Laboratory Supervisor to be present in the lab on a daily basis to ensure that safe and compliant practices are being carried out by all lab staff. For this reason, it is highly recommended that each instructor function as a Laboratory Safety Officer to manage the daily operations of the lab's safety program. The Laboratory Supervisor should empower the instructors to make decisions on daily operations involving safety and compliance, including the authority to instruct other lab personnel to follow all safety procedures (e.g., PPE use, hazardous waste procedures, etc.). Everyone involved should be familiar with how the lab operates and have demonstrated lab safety experience. Having instructors function as Laboratory Safety Officers in each lab provides many benefits such as:

1. Other lab personnel know who to contact with questions about daily operations involving safety and compliance;
2. Empowers someone other than the Laboratory Supervisor to enforce lab safety rules;
3. Provides consistency within the respective academic department; idea is that each Laboratory Safety Officer attends departmental safety committee meetings and reports issues back to the lab; and

4. Provides good, marketable experience for the Laboratory Supervisor/or Chemical Hygiene Officer to be involved in a safety leadership role.

The role of the Laboratory Safety Officer should include:

1. Provide training to new lab personnel; ensure appropriate training is given and that the training is properly documented;
2. Enforce lab safety rules;
3. Attend departmental/college level safety committee meetings and report significant information back to the lab; and
4. Report safety issues back to the PI when necessary.

1.8 NON-LABORATORY PERSONNEL / SUPPORT STAFF RESPONSIBILITIES

Custodians and maintenance staff (support staff) often must enter laboratories to perform routine tasks such as cleaning and equipment maintenance. Support staff members are expected to follow the posted safety rules of each laboratory. Minimum PPE requirements for support staff working in a laboratory are safety glasses, long pants, and closed-toe and closed heel shoes. If additional PPE is required or if other unique safety requirements must be followed, it is the lab personnel's responsibility to notify support staff. The procurement of support staff PPE as well as training is the responsibility of the Chemical Hygiene Officer.

1.9 CHEMICAL HYGIENE OFFICER RESPONSIBILITIES

The Chemical Hygiene Officer, who is the Executive Director of Auxiliary Operations & Physical Plant, or designated individual(s), has the primary responsibility for ensuring the implementation of all components of the CHP. The Chemical Hygiene Officer must:

1. Inform the Laboratory Supervisor and Laboratory Safety Officers (instructors) of all health and safety requirements and assist with the selection of appropriate safety controls (engineering controls, administrative controls, and PPE);
2. Ensure that the Laboratory Supervisor has the necessary resources to maintain compliance with the CHP and that all lab staff receive appropriate training;
3. Conduct periodic lab inspections and immediately take steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards;
4. Ensure that SOPs and hazard assessments are being prepared;
5. Maintain employee exposure-monitoring records, when applicable;
6. Help to develop and implement appropriate environmental health and safety policies and procedures;
7. Review and evaluate the effectiveness of the CHP program at least annually and update it as appropriate; and
8. Actively enforce all applicable safety procedures and ensure the contents of the CHP are followed; take appropriate actions when safety procedures are not followed.

1.10 AUXILIARY OPERATIONS & PHYSICAL PLANT DEPARTMENT

The Auxiliary Operations & Physical Plant Department (AOPP) has numerous roles at SCU and serves as the environmental health and safety department for the University. One of AOPP's roles is to manage regulatory compliance with all federal, state, and SCU regulations involving environmental health and safety issues. AOPP facilitates a number of programs that apply to laboratory safety, a few of which include biological safety, laser safety, personal protective equipment program, radiation safety, development of standard operating procedures, as well as the CHP. AOPP also performs numerous safety inspections of facilities throughout the year to monitor compliance with regulatory requirements. AOPP provides a variety of services such as training, chemical, biological, and radioactive waste pickups, and safety consultation. AOPP does not operate under a specific college or educational department of the University; rather, AOPP reports directly to the University Administration via the Vice President for Administration and Finance.

2. INTEGRATED HEALTH & SAFETY PLAN (IHSP)

It is the policy of SCU to integrate environmental health and safety into all operations. The IHSP is SCU's safety program, which is facilitated by AOPP, and was developed to provide a framework for laboratories to comply with environmental health and safety (EHS) regulations. The IHSP assists in communication of EHS issues across the organization and calls for college and program level safety committees and internal self-audits. The IHSP provides indemnification from regulatory fines for entities with a certified safety program. An IHSP certified safety program must have the following elements:

1. Regular safety committee meetings;
2. Means of communicating safety issues to the departments and/or divisions in a timely manner;
3. Upper administrative support for safety;
4. Self-audits checklists completed for all areas;
5. Abatement of deficiencies found during the self-audits;
6. An annual safety program audit and walk-through by AOPP; and
7. Recommendation for IHSP certification renewal from AOPP.

2.1 CHEMICAL AND LABORATORY SAFETY COMMITTEE (SACC)

SCU has established the Safety and Compliance Committee with the responsibility to promote safe and proper chemical management at all SCU campuses and related facilities. Chemical management includes, but is not limited to, the procurement and the safe handling, use, storage, and disposal of chemicals. SACC reviews lab safety programs and makes recommendations to the various Division/Department Chairs and Deans as appropriate. SACC consists of members selected for appointment by the Vice-President for Administration and Finance and include representation from the Basic Sciences Department, Division of Health Professions, University Health System, the Division of Professional Studies, as well as Physical Plant and Auxiliary Operations. Although AOPP facilitates the content of the CHP, it is ultimately the responsibility of SACC to approve changes and updates to the CHP.

SACC is scheduled to meet weekly (with some exceptions) and is chaired by the Vice-President for Administration and Finance.

2.2 COMMUNICATION OF SAFETY ISSUES

As mentioned above, SACC can make recommendations to the various Division/Department Chairs, Deans, or other University Administrators as it deems necessary. These recommendations can be informal or formal. However, should an issue come to the attention of the Committee that represents a significant risk to health or safety, SACC may take a more immediate approach to communication, including – if necessary – working with AOPP to issue an emergency alert via the University's existing Emergency Notification System

In addition to suggestions, SACC can issue Lab Inspection reports for instances where lab workers have knowingly breached protocol by not following the regulations laid out in this CHP or any additional Safety Manual or training.

2.3 CABINET LEVEL SPONSOR

The Vice President for Administration and Finance is the Cabinet Level sponsor.

2.4 SELF-AUDITS

SACC reserves the right to create individual lab safety self-audit checklist, but will – at a minimum – follow the format featured in Appendix B. Monthly inspections of the labs are part of the responsibilities of the Laboratory Supervisor (see 1.5 above).

2.5 ABATEMENT OF DEFICIENCIES

Should any University worker or SACC member bring deficiencies concerning lab safety to the attention of the group at large, it is the primary responsibility of AOPP to address the issues and develop an appropriate action plan. Should the abatement necessitate the removal or hazardous chemicals, AOPP is the only department at SCU certified under OSHA's Hazardous Waste Operations and Emergency Response Standard (HazWhoper); consequently, only AOPP can schedule and sign for waste removal.

2.6 ANNUAL SAFETY PROGRAM AUDIT

At least annually, the Executive Director of AOPP and Assistant Director of AOPP perform a self-audit of the CHP and full walk-through of each lab associated with the University. Recommendations for changes to lab practices or the CHP are made to SACC, or – if immediate action is needed – the Vice President for Administration and Finance.

2.7 RENEWAL OF COMMITTEE CERTIFICATION

Based on the findings of the audit covered in 2.6 above, the Executive Director of AOPP will make a recommendation to the Vice President for Administration and Finance to renew the certification for the SACC Committee.

3. CHEMICAL CLASSIFICATION SYSTEMS

Chemical classification systems are designed to communicate hazards. The three most widely used classification systems are the OSHA Globally Harmonized System (GHS) for Classifying and Labeling Chemicals (recently adopted and implemented under the OSHA Hazard Communication Standard), the National Fire Protection Association (NFPA) system of classifying the severity of hazards, and the Department of Transportation (DOT) hazard classes. These classification systems are used by chemical manufacturers when creating safety data sheets and chemical labels, therefore it is important that SCU lab employees understand the basic elements of each classification system.

3.1 GLOBALLY HARMONIZED SYSTEM FOR CLASSIFYING CHEMICALS (GHS)

The Globally Harmonized System (GHS) is a world-wide system adopted by OSHA for standardizing and harmonizing the classification and labeling of chemicals. The objectives of the GHS are to:

1. Define health, physical, and environmental hazards of chemicals;
2. Create classification processes that use available data on chemicals for comparison with the defined hazard criteria (numerical hazard classification is based on a 1 – 5 scale, 1 being the most hazardous and 5 being the least hazardous); and
3. Communicate hazard information, as well as protective measures, on labels and Safety Data Sheet (SDS), formerly known as Material Safety Data Sheets (MSDS).

3.2 SAFETY DATA SHEETS

The SDS provides comprehensive information that is imperative for the safe handling of hazardous chemicals. Laboratory personnel should use the SDS as a resource to obtain information about hazards and safety precautions. SDSs cannot provide information for hazards in all circumstances. However, the SDS information enables the employer to develop an active program of worker protection measures such as training on hazard mitigation. Chemical manufacturers are required to use a standard format when developing SDSs. The SDS will contain 16 headings which are illustrated in Figure 3.2.1.

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

Figure 3.1 – Required Sections of GHS Safety Data Sheets

3.3 CHEMICAL LABELING

The GHS standardized label elements, which are not subject to variation and must appear on the chemical label, contain the following elements:

- Symbols (hazard pictograms) are used to convey health, physical and environmental hazard information, assigned to a GHS hazard class and category;
- Signal Words such as "Danger" (for more severe hazards) or "Warning" (for less severe hazards), are used to emphasize hazards and indicate the relative level of severity of the hazard assigned to a GHS hazard class and category;
- Hazard statements (e.g., "Danger! Extremely Flammable Liquid and Vapor") are standard phrases assigned to a hazard class and category that describe the nature of the hazard; and
- Precautionary statements are recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to the hazardous chemical.

GHS also standardizes the hazard pictograms that are to be used on all hazard labels and SDSs. There are 9 pictograms that represent several defined hazards, and include the harmonized hazard symbols which are intended to convey specific information about each hazard. Figure 3.2.2 illustrates these GHS hazard pictograms.

		
Carcinogen, Respiratory Sensitizer, Reproductive Toxicity, Target Organ Toxicity, Mutagenicity	**Flammable, Pyrophoric, Self-Heating, Emits Flammable Gas, Organic Peroxide**	**Irritant, Dermal Sensitizer, Acute Toxicity (harmful), Narcotic Effects**
		
Gas Under Pressure	**Corrosive**	**Explosive, Organic Peroxide, Self-Reactive**
		
Oxidizer	**Environmental Toxicity**	**Acute Toxicity (Severe)**

Figure 3.2 – GHS Hazard Pictograms

GHS labeling requirements are only applicable to chemical manufacturers, distributors, and shippers of chemicals. GHS labeling requirements are not required for chemicals being stored in a laboratory. However, since most chemicals stored in the laboratory have been purchased from a chemical manufacturer, the GHS labeling and pictogram requirements are very relevant and must be understood by laboratory employees. **By the end of calendar year 2015, SCU will have fully adopted the GHS system**. Figure 3.2.3 illustrates the GHS label format showing the required elements.

ACETONE

PRODUCT IDENTIFIER

Code:
Product Name:

SUPPLIER IDENTIFICATION

Company Name:
Street Address:
City: State:
Postal Code:
Phone Number:

PRECAUTIONARY STATEMENTS

Keep away from heat, sparks, open flames, hot surfaces – No smoking.
Avoid breathing dust, fumes, gas, mist, vapors, and spray.
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Repeated exposure may cause skin dryness and cracking.
In Case of Fire: Use water spray, alcohol-resistant foam, dry chemical, or carbon dioxide.
First Aid: Move out of dangerous area. Consult a physician. If inhaled, move person to fresh air. If not breathing, give artificial respiration. In case of skin contact, wash with soap and plenty of water. In case of eye contact, rinse thoroughly with plenty of water for at least 15 minutes. If swallowed, do not induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water, consult a physician.

HAZARD PICTOGRAMS

SIGNAL WORD

Danger

HAZARD STATEMENT

Highly flammable liquid and vapor.
Causes mild skin irritation.
Causes serious eye irritation.
May cause drowsiness or dizziness.

Figure 3.2.3 – GHS Label Format

As mentioned earlier, one of the objectives of GHS was to create a quantitative hazard classification system (numerical hazard classification is based on a 1 – 5 scale, 1 being the most hazardous and 5 being the least hazardous) based on physical characteristics such as flash point, boiling point, lethal dose of 50% of a population, reactivity, etc.

Table 3.2.1 illustrates how the numerical hazard classification works for flammable liquids. More detailed information on GHS can be found on the OSHA website.

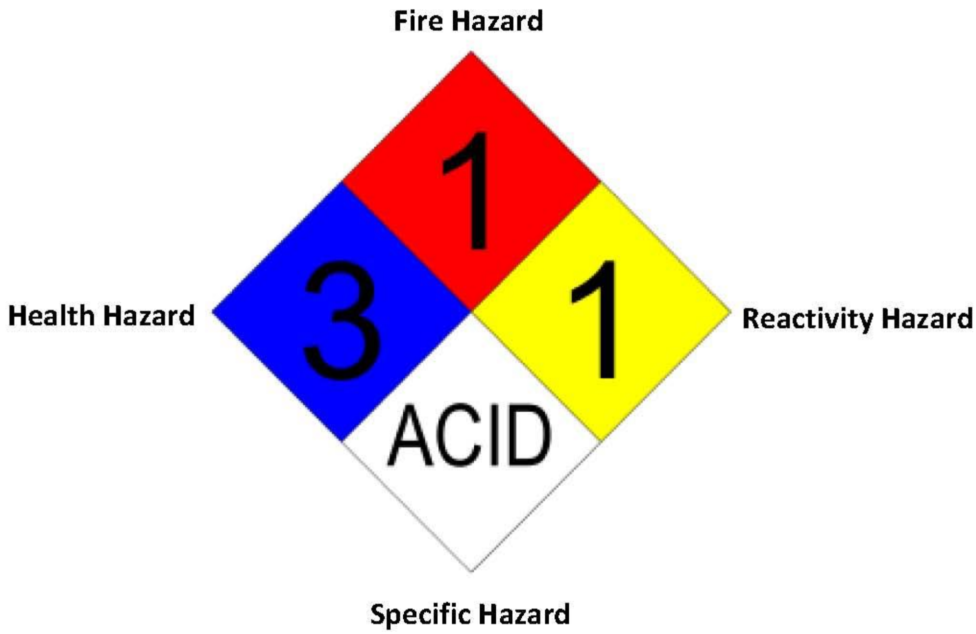
(https://www.osha.gov/dsg/hazcom/ghs.html)

Category	Criteria	Signal Word	Hazard Statement
1	Flash point < 23 °C Boiling point < 35 °C	Danger	Extremely flammable liquid and vapor
2	Flash point < 23 °C Boiling point > 35 °C	Danger	Highly flammable liquid and vapor
3	Flash point > 23 °C and < 60 °C	Warning	Flammable liquid and vapor
4	Flash point > 60 °C and < 93 °C	Warning	Combustible liquid
5	There is no Category 5 for flammable liquids		

Table 3.2.1 – GHS Hazard Classification System for Flammable Liquids

3.4 NATIONAL FIRE PROTECTION ASSOCIATION RATING SYSTEM

The NFPA system uses a diamond-shaped diagram of symbols and numbers to indicate the degree of hazard associated with a particular chemical. This system was created to easily and quickly communicate hazards to first responders in the event of an emergency situation. These diamond-shaped symbols are placed on chemical containers to identify the degree of hazard associated with the specific chemical or chemical mixture. The NFPA system is a common way to identify chemical hazards and should be understood by laboratory employees. The NFPA 704 numerical rating system is based on a 0 – 4 system; 0 meaning no hazard and 4 meaning the most hazardous (note: this in contrast to the GHS system where 1 is the most hazardous and 4 is the least hazardous). Figure 3.4 illustrates the NFPA hazard rating system and identifies both the hazard categories and hazard rating system.



Health Hazard	Fire Hazard	Reactivity Hazard	Specific Hazard
4 - Deadly	**4** - FP* < 73° F	**4** - May Detonate	**ACID** Acid
3 - Extreme Danger	**3** - FP < 100° F	**3** - Shock/Heat May Detonate	**ALK** Alkali
2 - Hazardous	**2** - 100° F < FP < 200° F	**2** - Violent Chemical Change	**COR** Corrosive
1 - Slightly Hazardous	**1** - FP > 200° F	**1** - Unstable if Heated	~~**W**~~ No Water
0 – Normal Material	**0** - Will Not Burn	**0** - Stable	☢ Radioactive
	**** FP = Flash Point***		

Figure 3.4 – NFPA Hazard Rating System

3.5 DEPARTMENT OF TRANSPORTATION (DOT) HAZARD CLASSES

The DOT regulates the transportation of all hazardous materials in the United States. All hazardous chemicals must be properly labeled by the chemical manufacturer or distributor before transportation occurs. Chemical containers stored in laboratories are not required to be labeled per DOT standards; however the DOT 9 hazard classes are often seen on chemical containers and are discussed in Section 14 of GHS-formatted SDSs. The DOT 9 hazard classes are illustrated below in Figure 3.5. It should be noted that Figure 3.5 only lists the primary hazard classes, the sub classes (e.g., Organic Peroxides, DOT Class 5.2) were omitted for stylistic purposes.

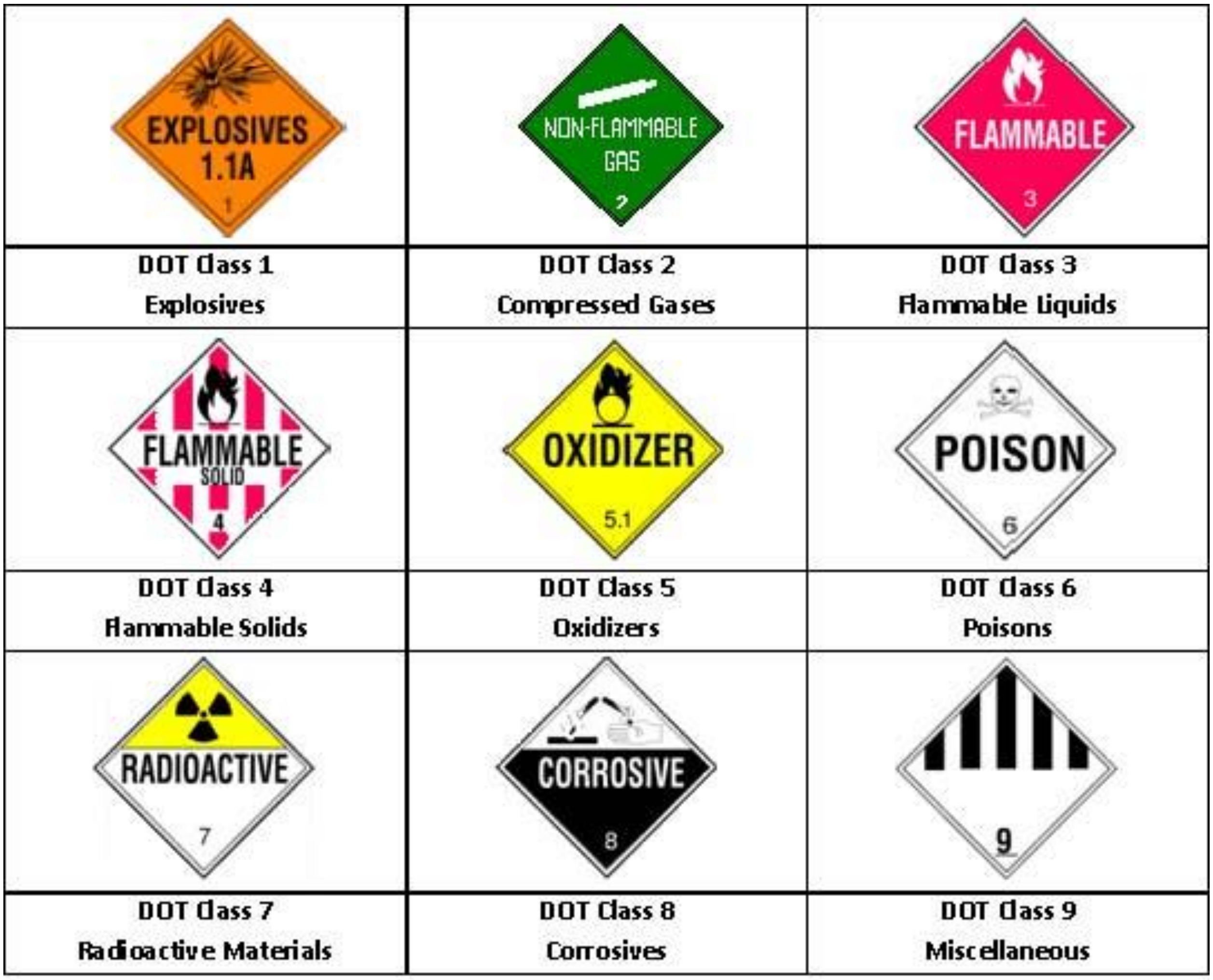


Figure 3.5 – NFPA Hazard Rating System

4. CLASSES OF HAZARDOUS CHEMICALS

Chemicals can be divided into several different hazard classes. The hazard class provides information to help determine how a chemical can be safely stored and handled. Each chemical container, whether supplied by a chemical manufacturer or produced in the laboratory, must have a label that clearly identifies the chemical constituents. In addition to a specific chemical label, more comprehensive hazard information can be found by referencing the SDS for that chemical. The OSHA Laboratory Standard defines a hazardous chemical as any element, chemical compound, or mixture of elements and/or compounds which is a physical or health hazard. This definition of a hazardous chemical and the GHS primary classes of chemicals are briefly discussed below.

4.1 PHYSICAL HAZARDS

A chemical is a physical hazard if there is scientifically valid evidence that it is flammable, combustible, compressed gas, explosive, organic peroxide, oxidizer, pyrophoric, self-heating, self-reactive, or water-reactive. Each physical hazard is briefly defined below. Refer to Appendix B (section B.1) for detailed information on each physical hazard.

Explosives: A liquid or solid which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings.

Flammable Liquids: Materials which under standard conditions can generate sufficient vapor to cause a fire in the presence of an ignition source and have a flash point no greater than 93 °C (200 °F).

Flammable Solid: A solid which is readily combustible, or may cause or contribute to a fire through friction.

Gases under Pressure: Gases which are contained in a receptacle at a pressure not less than 280 kPA at 20 °C or as a refrigerated liquid.

Organic Peroxide: A liquid or solid which contains the bivalent -0-0- structure and may be considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals.

Oxidizer: A liquid or solid, while in itself is not necessarily combustible, may generally by yielding oxygen, cause or contribute to the combustion of other material.

Pyrophoric Substance (also called Spontaneously Combustible): A liquid or solid that even in small quantities and without an external ignition source can ignite after coming in contact with the air.

Self-Heating Substance: A liquid or solid, other than a pyrophoric substance, which, by reaction with air and without energy supply, is liable to self-heat.

Self-Reactive Substance: A liquid or solid that is liable to undergo strong exothermic thermal decomposition even without participation of oxygen (air).

Water-Reactive Substance: A liquid or solid that reacts violently with water to produce a flammable or toxic gas, or other hazardous conditions.

4.2 HEALTH HAZARDS

A chemical is a health hazard if 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. Each health hazard is briefly defined below. Refer to Appendix B (section B.2) for detailed information on each health hazard.

Carcinogens: Substances that cause cancer. Generally they are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period. Carcinogens are separated into two classes: select carcinogens and regulated carcinogens.

Corrosives: Substances that cause destruction of living tissue by chemical corrosion at the site of contact and can be either acidic or caustic (basic).

Hazardous Substances with Toxic Effects on Specific Organs: Substances that pose adverse health effects to specific organs such as the liver, kidneys, lungs, etc.

High Acute Toxicity Substances: Substances that may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration. Acute toxins are quantified by a substance's lethal dose-50 (LD50) or lethal concentration-50 (LC50), which is the lethal dose of a compound to 50% of a laboratory tested animal population (e.g., rats, rabbits) over a specified time period.

Irritant: Substances that cause reversible inflammatory effects on living tissue by chemical action at the site of contact.

Reproductive Toxins: Substances that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogens).

Sensitizer (also called allergen): A substance that causes exposed individuals to develop an allergic reaction in normal tissue after repeated exposure to the substance.

4.3 BIOLOGICAL HAZARDS

Biological hazards are hazards which involve an organism that presents a risk to humans, plants, animals, or the environment. The Laboratory Supervisor must submit to SACC an application to use rDNA, synthetic nucleic acids, potential pathogens, human tissue, fluids, and/or cell lines in their research. A review is conducted in accordance with the guidance and requirements of National Institutes of Health, the Centers for Disease Control, and SCU policies. The Laboratory Supervisor has an obligation to be closely familiar with EHS guidelines applicable to their work and to adhere to them

4.4 RADIOACTIVE MATERIAL HAZARDS

Radioactive Hazards are those involving radioactive material and radiation producing devices. The Chair of Diagnostic Imaging must directly submit to the Chemical Hygiene Officer, an application to use radioactive material or radiation-producing devices. Use of radioactive materials requires a license issued by the US Nuclear Regulatory Commission or a registration with the California State Department of Health and all work must comply with applicable regulations. Prior to application for licensure, the proposed usage of radioactive material will first be vetted through SACC.

4.5 LASER HAZARDS

Laser hazards involve laser radiation devices. The Lab Supervisor must submit to the Chemical Hygiene Officer, an application to use Class 3B and Class 4 lasers or laser devices. The use of lasers is subject to OSHA regulations and utilizes current ANSI standards to develop guidance, and will first be vetted through SACC prior to being adopted for laboratory usage.

5. LABORATORY SAFETY CONTROLS

Laboratory safety controls include engineering controls, administrative controls, and PPE. Elements of these three categories should be used in a layered approach to minimize employee exposure to hazardous chemicals. There are four primary routes of exposure in which hazardous substances can enter the body:

1. Inhalation;
2. Absorption;
3. Ingestion; and
4. Injection.

Of these, the most likely routes of exposure in the laboratory are by inhalation and/or skin absorption. Many hazardous chemicals may affect people through more than one of these exposure modes, so it is critical that protective measures are in place for each of these exposure routes.

5.1 ENGINEERING CONTROLS AND SAFETY EQUIPMENT

Exposure to hazardous materials must be controlled to the greatest extent feasible by use of engineering controls. Engineering controls to reduce or eliminate exposures to hazardous chemicals include:

- Substitution with less hazardous equipment, chemicals, or processes (e.g., safety cans for glass bottles);
- Isolation of the operator or the process (e.g., use of a glove box when handling air- or water-sensitive chemicals); and
- Use of forced ventilation systems (e.g., chemical fume hood, biological safety cabinet).

5.1.1 CHEMICAL FUME HOODS

A chemical fume hood is a type of local ventilation installation that is designed to limit exposure to hazardous or toxic fumes, vapors, or dusts. To determine if a chemical is required to be used inside of a chemical fume hood, first check the SDS for that chemical. Statements found in Section 2 on a SDS such as “do not breathe dust, fumes, or vapors” or “toxic by inhalation” indicate the need for ventilation. As a best practice, always use a chemical fume hood for all work involving the handling of open chemicals (e.g., preparing solutions) whenever possible. If a chemical fume hood is required or recommended to be used, the following guidelines must be followed at all times:

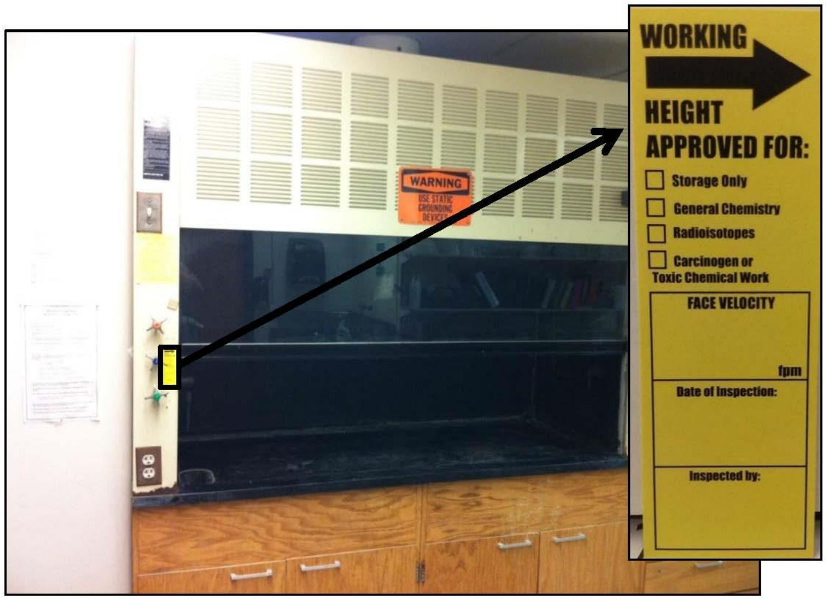


Figure 5.1 – Chemical Fume Hood Sash Approved Working Height

Chemical fume hoods must be marked to indicate the proper sash position for optimum hood performance as illustrated in Figure 5.1. The chemical fume hood sash should be positioned at this height whenever working with hazardous chemicals that could generate toxic aerosols, gases, or vapors. In general, the sash height should be set at a level where the operator is shielded to some degree from any splashes, explosions, or other violent reactions which could occur and where optimum air flow dynamics are achieved. Most chemical fume hoods are not intended to be used with the sash fully open. The sash should only be fully opened to add or remove equipment from the chemical fume hood.

Chemical fume hoods must be equipped with a continuous reading monitoring device to indicate adequacy of flow. All lab employees must know how to read and interpret this gauge and check that the chemical fume hood is operating properly before using hazardous chemicals in the fume hood. There are different types of chemical fume hoods used at each campus, so it is important that the lab employee understands the specific functions of each chemical fume hood used.

Only apparatus and chemicals essential to the specific procedure or process should be placed in the chemical fume hood. Extraneous materials from previous experiments should be removed and stored in a safe location outside the chemical fume hood.

Chemical fume hoods used for experimental work should not be used for chemical or material storage. Chemical fume hoods are never to be used for chemical storage. No experimental work should be conducted in storage chemical fume hoods.

All chemical containers used in chemical fume hoods, including secondary containers (e.g., beakers, flasks, reaction vessels, vials, etc.) must be labeled. If is not practical to label a secondary container that is in process (e.g., reaction vessel, flask), a temporary label can be used as shown in Section 5.7 of the CHP. Reaction vessels in chemical fume hoods must be labeled as well. If labeling the vessel itself is not practical, the hood sash or wall may be labeled as illustrated in Figure 5.2.

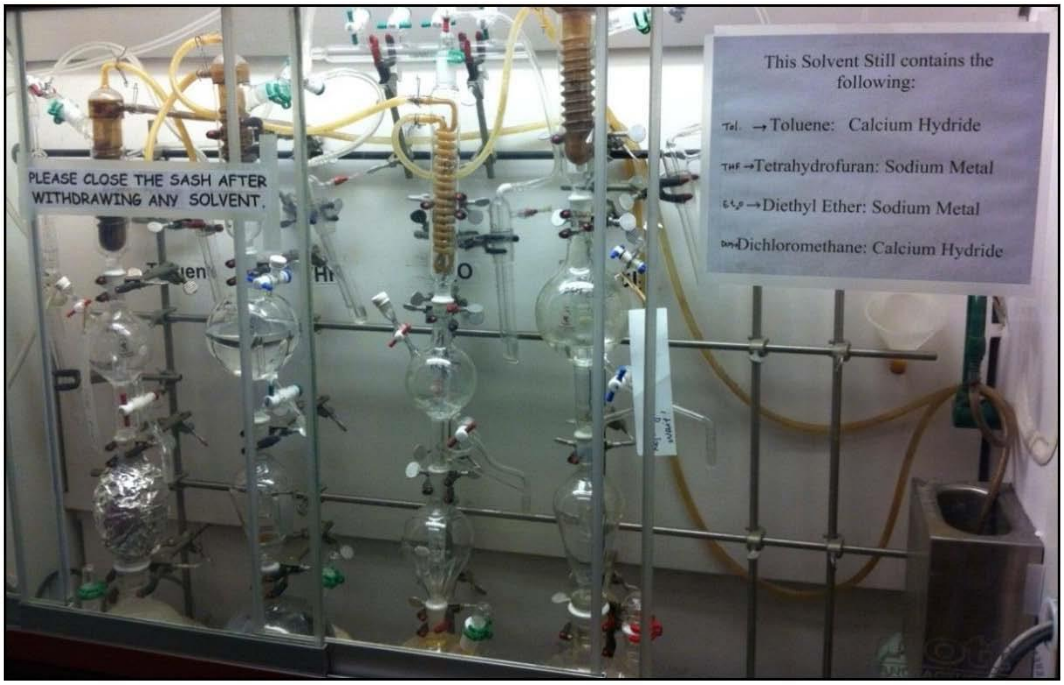


Figure 5.2- Alternative Labeling of Chemical Fume Hood Reaction Vessels

- Do not allow the vents or air flow baffles to be blocked;
- Never put your head inside of an operating chemical fume hood; and
- All chemical fume hoods should be routinely checked for airflow by measuring the face velocity, which should be between 70 – 125 feet per minute.

5.1.2 GLOVE BOXES

A glove box, as illustrated in Figure 5.3, is a sealed container that is designed to allow one to handle material in a defined atmosphere (typically inert). Glove boxes can be used to protect sensitive items inside or the user on the outside, or both. The following recommendations should be followed by all personnel using a glove box:

Figure 5.3 – Glove Box

All personnel must receive documented training from the PI or delegate before any work in a glove box occurs. All trained personnel must understand the design features and limitations of a glove box before use. The training must include detailed instruction on elements such as the ventilation and vacuum controls that maintain a pressure differential between the glove box and outside atmosphere, atmospheric controls (e.g., controlling oxygen concentrations and moisture), etc.

Prior to use, a visual glove inspection must be performed. Changing of a glove must be documented (date, manufacturer, model of glove, and person performing change). Gloves should not be used until they fail; they should be changed according to the glove box manufacturer's recommendations or whenever necessary.

Plugging ports that are never or infrequently used is recommended. A properly plugged port should have a stub glove and a glove port cap installed.

Chemical resistant gloves (e.g., disposable nitrile gloves) should be used under the glove box gloves to protect from contamination.

The glove box pressure must be checked every day, before use and immediately after gloves are changed. The pressure check must be documented.

Keep sharps in an approved container while in the glove box.

Do not work in the glove box unless the lighting is working.

Follow all safe work practices for using and handling compressed gas that may be associated with working in the glove box.

All equipment and chemicals in the glove box must be organized and all chemicals must be labeled. Do not allow items, particularly chemicals to accumulate in the glove box.

5.1.3 LAMINAR FLOW CLEAN BENCHES

A laminar flow clean bench is an enclosed bench designed to prevent contamination of semiconductor wafers, samples, or any particle sensitive device. Air is drawn through a filter and blown in a very smooth, laminar flow towards the user. Therefore it is critical that absolutely no hazardous chemicals, infectious and/or radioactive materials ever be used in a laminar flow clean bench, as the vapors are blown directly towards the user. Applications that involve the use of chemicals should be conducted in chemical fume hoods.

5.1.4 BIOLOGICAL SAFETY CABINETS (BSC)

A biological (or biosafety) safety cabinet, is an enclosed, ventilated laboratory workspace for safely working with materials contaminated with (or potentially contaminated with) infectious materials. The primary purpose of a biosafety cabinet is to serve as a means to protect the laboratory worker and the surrounding environment from pathogens. All exhaust air is filtered as it exits the biosafety cabinet, removing harmful particles. Biological safety cabinets are not designed to be used with chemical applications so the use of chemicals should be kept to a minimum. Applications that involve the use of chemicals should be conducted in chemical fume hoods. A thorough understanding of BSC operations should be known prior to any usage.

5.1.6 SAFETY SHOWERS AND EYEWASH STATIONS

All laboratories using hazardous chemicals must have immediate access to safety showers and eye wash stations (some of which may be portable). Safety showers must have a minimum clearance of 24 inches from the centerline of the spray pattern in all directions at all times. Identify the safety station with a highly visible sign and maintain an unobstructed path to it. All lab personnel must be aware of the location and know how to properly use the safety shower and eyewash stations. If lab personnel are exposed to a hazardous chemical, they should dial 911 (or someone else in the lab that is not exposed should dial 911) and use the safety shower and/or eye wash unit for 15 minutes or until emergency response have personnel arrive and begin treatment. If an uninjured individual is present, this person should assist with the decontamination of the affected individual.

All eyewash stations must be flushed by laboratory personnel on a weekly basis to ensure proper working order. This will keep the system free of sediment and prevent bacterial growth from reducing performance.

AOPP performs monthly inspections of all campus safety shower and eyewash stations. This inspection evaluates the basic mechanical functionality of each station. Any deficiencies are repaired by AOPP staff. If the safety shower or eye wash unit becomes inoperable, notify your direct supervisor and/or the Lab Supervisor immediately.

5.1.7 FIRE EXTINGUISHERS

All fire extinguishers should be mounted on a wall in an area free of clutter. Each fire extinguisher on campus is inspected on an annual basis by the Local Fire Department. All laboratory personnel should be familiar with the location, use, and classification of the extinguishers in their laboratory. Ensure that the fire extinguisher being used is appropriate for the type of material on fire before attempting to extinguish any fire. Laboratory personnel are not required to extinguish fires that occur in their work areas and should not attempt to do so unless:

1. It is a small, contained fire that can be quickly and safely extinguished (e.g., small trash can sized fire);
2. Appropriate training has been received and the individual feels the fire can be safely extinguished; and
3. It is necessary to extinguish a fire in order to exit an area (e.g., fire is blocking an exit).

If a fire occurs in the laboratory and is extinguished by lab personnel, the local Fire Department must still be contacted immediately by dialing 911.

5.1.8 FIRE DOORS

Many laboratories may contain fire doors as part of the building design. These doors are an important element of the fire containment system and should remain closed unless they are on a magnetic self-closure or other automated self-closing system. Never disable an automatic door closure device (e.g., placing a block under the door). If you are unsure of whether a door is fire rated or not, contact AOPP and a staff member will come to the area to evaluate the specific door in question.

5.1.9 ADMINISTRATIVE CONTROLS

Administrative controls are procedural measures which can be taken to reduce or eliminate hazards associated with the use of hazardous materials. Administrative controls include the following:

- Ensuring that employees are provided adequate documented training for safe work with hazardous materials;
- Careful planning of experiments and procedures with safety in mind. Planning includes the development of written SOPs and hazard assessments (discussed in detail in Chapter 6) for safe performance of the work;
- Restricting access to areas where hazardous materials are used;
- Using safety signs or placards to identify hazardous areas (designated areas);
- Labeling all chemicals;
- Substitution of toxic materials with less toxic materials, when possible;
- Good housekeeping and good personal hygiene such as routine hand washing and regular decontamination of areas that are possibly chemically contaminated such as bench-tops and fume hoods; and
- Prohibiting eating and drinking where chemicals are used or stored

5.1.10 STANDARD OPERATING PROCEDURESS (SOPS)

SOPs are written instructions that detail the steps that will be performed during a given procedure and include information about potential hazards and how these hazards will be mitigated. SOPs must be prepared by laboratory personnel who are the most knowledgeable and involved with the experimental process. However, the Laboratory Supervisor is ultimately responsible for approving SOPs regardless of who prepares them. The OSHA Lab Standard required SOPs to be developed for all high-hazard tasks that are performed in the lab. High hazard tasks include any work with the following types of chemicals:

<u>Explosives</u>

- Water-reactive, pyrophoric, self-heating, or self-reactive chemicals; and
- Particularly hazardous substances, which includes carcinogens, reproductive toxins, and acutely toxic substances

<u>Compressed gases</u>

- Work involving more than 1 liter of flammable liquids, flammable solids, corrosives, oxidizers, or organic peroxides at one time; and
- High-hazard tasks can also include work with equipment that creates particularly hazardous conditions. Examples include solvent distillation, work with high-pressure systems, hydrogenation, work with cryogenic chemicals such as liquid nitrogen, etc.

AOPP develops SOP templates (see Appendix C) that can be used by laboratories. These SOPs are not complete as is; they are templates that must be customized by each laboratory before they are considered complete.

5.1.11 REQUIRED LABORATORY POSTINGS

The following forms and labels are required to be posted in most campus laboratories:

- The Emergency Contact Door Posting is required for all laboratories;
- The Certification of Hazard Assessment Form is required for all laboratories. Detailed information regarding the hazard assessment process is presented in Section 7.1 of the CHP and an example Certification of Hazard Assessment Form is located in Appendix D;
- The Carcinogens, Reproductive Toxins, or Extremely Toxic Chemicals label (Toxic Chemicals Label), is required if a lab uses or stores any chemicals considered by OSHA to be select carcinogens, reproductive toxins and substances with a high degree of acute toxicity;
- A Proposition 65 warning is required if the lab uses or stores any chemicals known to the State of California to cause cancer, or birth defects or other reproductive harm.
- An Abbreviations, Acronyms, and Chemical Formulas list is required for all labs that use abbreviations, acronyms, and/or chemical formulas as a means to label chemical containers, including secondary containers such as beakers, flasks, and vials; and
- There are several other lab postings that may also be required that are not discussed in the CHP, particularly if radioisotopes and/or biological agents are used in the lab.

5.1.12 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal protective equipment (PPE) should be used to supplement engineering controls. However, PPE should never be used as a substitute for engineering controls when engineering controls are required. PPE must be worn at all time in the laboratory when handling hazardous chemicals. Proper PPE selection can be determined in the following ways:

- Ask the Laboratory Supervisor about proper PPE selection;

- Review the SOP and associated hazard assessment for the task to be performed;
- Review Section 8, “Exposure Controls/Personal Protection” of the SDS for the chemical(s) being used. This will provide basic information on the PPE recommended for use with the particular chemical. The SDS addresses "worst case" conditions; therefore, all the equipment described may not always be necessary for a specific job. In addition, the SDS may not provide sufficient information concerning a specific respirator or type of glove appropriate for the chemical; and
- Additional PPE requirements are detailed in the Laboratory PPE Policy in Chapter 5 and Chapter 9 of the CHP.

6. LABORATORY MANAGEMENT PLAN

An effective laboratory management plan is essential to operating a safe lab environment. Requirements on topics such as lab housekeeping, chemical inventories, proper handling, storage, segregation, and labeling of chemicals, and equipment safety must be established and known by all laboratory personnel. This chapter details how laboratories should be managed at SCU.

6.1 LABORATORY SAFETY GUIDELINES

All laboratory employees must have a good understanding of the hazards associated with the chemicals being used and stored in the lab. Basic factors such as the physical state (gas, liquid, or solid) of the chemical and the type of facilities and equipment involved with the procedure should be considered before any work with hazardous materials occurs

6.2 LABORATORY SAFETY QUESTIONS

Many factors are involved is laboratory safety. Asking and answering the following questions will help address many of the factors that should be considered when it comes to laboratory safety.

- Is the material flammable, explosive, corrosive, or reactive?
- Is the material toxic, and if so, how can I be exposed to the material (e.g., inhalation, skin or eye contact, accidental ingestion, accidental puncture)?
- What kind of ventilation do I need to protect myself?
- What kind of PPE (e.g., chemical-resistant gloves, respirator, and goggles) do I need to protect myself?
- Will the process generate other toxic compounds, or could it result in a fire, explosion, or other violent chemical reaction?
- What are the proper procedures for disposal of the chemicals?
- Do I have the proper training to handle the chemicals and carry out the process?
- Are my storage facilities appropriate for the type of materials I will be using?
- Can I properly segregate incompatible chemicals?
- What possible accidents can occur and what steps can I take to minimize the likelihood and impact of an accident? What is the worst incident that could result from my work?

6.3 GENERAL LABORATORY SAFETY RULES

It is extremely important that all laboratory safety rules are known and followed by lab personnel. Not only is it important that the rules are understood and followed, it is also important that the Laboratory Supervisor enforce all lab safety rules. A culture of safety must be adopted by all employees before a lab safety program can be successful. The following general laboratory safety rules should be followed at all times:

Prior to beginning work in the lab, be prepared for hazardous materials emergencies and know what actions to take in the event of an emergency. **Plan for the worst-case scenario**. Be sure that necessary supplies and equipment are available for handling small spills of hazardous chemicals. Know the location of safety equipment such as the nearest safety shower and eyewash station, fire extinguisher, spill kit, and fire alarm pull station.

Do not work alone in the laboratory if you are working with high hazard materials (e.g., acutely toxics, reactive, or processes that involve handling a large volume of flammable materials, > 1 liter).

If working with a high-hazard chemical, ensure that others around you know what you are working with and understand the potential hazards.

Limit access to areas where chemicals are used or stored by posting signs and/or locking doors when areas are unattended.

Purchase the minimum amount of hazardous materials necessary to efficiently operate the laboratory.

Ensure that adequate storage facilities (e.g., chemical storage rooms, flammable safety cabinets) and containers are provided for hazardous materials. Ensure that hazardous materials are properly segregated by chemical compatibility.

Ensure that ventilation is adequate for the chemicals being used. Understand how chemical fume hoods function and be able to determine if the hood is not functioning properly.

Use good personal hygiene practices. Keep your hands and face clean; wash thoroughly with soap and water after handling any chemical.

Smoking, drinking, eating, and the application of cosmetics are forbidden in areas where hazardous chemicals are in use. Confine long hair and loose clothing.

Never smell or taste a hazardous chemical. Never use mouth suction to fill a pipette.

When using equipment that creates potential hazards (e.g., centrifuge), ensure that the equipment is being used following the manufacturer's guidelines and instructions. If equipment requires routine maintenance (e.g., HEPA filters need to be changed), ensure the maintenance is performed by a qualified individual.

Use required PPE as instructed by the PPE Policy detailed in Chapter 6.

6.4 HOUSEKEEPING

Housekeeping is an important element to a laboratory safety program. A clean, well-maintained lab improves safety by preventing accidents and can enhance the overall efficiency of the work being performed. The following laboratory housekeeping guidelines should be followed:

- All doorways and hallways must be free of obstructions to allow clear visibility and exit. The laboratory should be uncluttered without excessive storage of materials that could cause or support a fire (e.g., paper, cardboard, flammable liquids, etc.);
- Fire protection sprinklers must be unobstructed; a minimum of 18 inches of clearance is required below the sprinkler head. If the laboratory does not have fire protection sprinklers, there must be a minimum of 24 inches of clearance below the ceiling;
- Do not store items that block fire extinguishers or eyewash and safety shower stations.
- Do not store items in front of electrical boxes/panels in the lab;
- A routine cleaning schedule should be established. All work surfaces should be kept as clean as possible. All potentially chemically contaminated work area surfaces (e.g., chemical fume hood deck, countertops) should be cleaned routinely (e.g. daily, weekly);
- For operations where spills and contamination are likely (e.g., agarose gel electrophoresis/ethidium bromide applications), cover work spaces with a bench paper or liner. The soiled bench paper should be changed on a routine basis or as needed;
- All chemical spills must be cleaned up immediately. Refer to Chapter 8 of the CHP for detailed chemical spill cleanup procedures;
- Do not allow materials to accumulate in laboratory hoods and remove used tissues, foil, gloves, or other unnecessary objects immediately after use. The safety of the workspace and the hood ventilation may be compromised when excessive chemicals and equipment are kept in hoods;
- Ensure that all waste (e.g., trash, chemically contaminated waste, etc.) is placed in the appropriate containers. Do not overfill waste containers;
- All equipment should be cleaned and returned to storage after each use;
- Equipment should be stored in a safe and orderly manner that prevents it from falling;
- Chemical containers must be clean, properly labeled, and returned to storage upon completion or usage. Avoid storing liquids above eye level; and
- Do not store heavy or frequently used items on top shelves. Locate items used daily close to the work area.

6.5 CHEMICAL INVENTORIES

It is a prudent practice to develop and maintain a chemical inventory. Taking a routine chemical inventory can reduce the number of unknown chemicals and the tendency to stockpile chemicals. AOPP recommends that all laboratories take a chemical inventory at least once each trimester. Depending on the type of chemicals being used and stored in a laboratory, AOPP may require that a chemical inventory be prepared for a room, work unit, or department (e.g., Department of Homeland Security Chemical Facility Anti-Terrorism Standards Inventory) on a routine basis.

6.6 SAFETY DATA SHEETS

The SDS provides comprehensive information that is imperative for the safe handling of hazardous chemicals. Carefully read the label and SDS and make sure that you understand the information provided in this document before using a chemical. In some cases it may be necessary to do additional research. For safety and convenience a SDS binder is featured in each lab. The Laboratory Supervisor should be consulted if necessary.

It is important that all lab employees have access to SDS for all hazardous chemicals that are stored in the lab. Access can mean storing hard copies of SDS in the lab or some other easily accessible location (e.g., departmental main office), or can mean storing electronically by a means that is also accessible to all lab personnel (e.g., shared network drive). To obtain a copy of a SDS, contact the chemical manufacturer or AOPP. Many manufacturers' SDS can be found online on websites such as Siri MSDS Index. The links to these resources are included below:

Siri MSDS Index (http://hazard.com/msds/)

Sigma-Aldrich Product Search (http://www.sigmaaldrich.com/united-states.html)

6.7 CHEMICAL LABELING REQUIREMENTS

Every chemical container present in the laboratory, whether hazardous or not, must be properly labeled. All secondary chemical containers (e.g., wash bottles, beakers, flasks, sample vials, etc.) must also be properly labeled. Avoid using abbreviations, chemical formula, or structure unless there is a complete and up-to-date legend (e.g., MeOH = Methanol) prominently posted in the lab. Most chemicals come with a manufacturer label that contains all of the necessary information, so care should be taken to not damage or remove these labels. It is recommended that each bottle also be dated when received and when opened to assist in determining which chemicals are expired and require proper disposal. When labeling secondary chemical container, utilize the HMIS (or GHS) system to properly identify the contents of the container.

6.8 CHEMICAL SEGREGATION

All chemicals must be stored according to chemical compatibility. Once segregated by chemical compatibility, they can then be stored alphabetically. Information regarding chemical compatibility can be found in the SDS, primarily in Section 7, "Handling and Storage" and Section 10, "Stability and Reactivity". If unsure of proper segregation procedures, contact the Laboratory Supervisor for assistance. Chemical segregation can be achieved by either isolation (e.g., organic solvents stored in a flammable cabinet), physical distance (e.g., acids and bases are stored on opposite sides of a chemical storage room), or secondary containment (e.g., placing oxidizing acids such as nitric acid into a secondary containment to segregate from organic acids such as formic acid as shown in Figure 6.7). In the most general terms, proper segregation can be achieved by:

- Storing acids away from bases and toxics;
- Storing oxidizers away from organic chemicals; and

- Storing reactive and acutely toxic materials away from all other chemicals.

Table 6.1- Chemical Compatibility Chart

Table 6.1 illustrates a more detailed chemical compatibility logic that can be used for chemical storage. Hazard classes marked by an X need to be segregated from each other (e.g., Acid, inorganic must be segregated from Base, inorganic). Contact the Laboratory Supervisor with questions regarding chemical segregation.

	Acid, inorganic	Acid, organic	Acid, oxidizer	Base, inorganic	Base, organic	Oxidizer	Toxic, inorganic	Toxic, organic	Reactive	Organic solvent
Acid, inorganic				X	X		X	X	X	
Acid, organic			X	X	X	X	X	X	X	
Acid, oxidizer		X		X	X		X	X	X	X
Base, inorganic	X	X	X						X	
Base, organic	X	X	X			X			X	
Oxidizer		X			X			X	X	X
Toxic, inorganic	X	X	X						X	
Toxic, organic	X	X	X			X			X	
Reactive	X	X	X	X	X	X	X	X		X
Organic solvent			X			X			X	

6.9 CHEMICAL STORAGE REQUIREMENTS

Proper storage of chemicals is an essential component to a laboratory safety program. Improper chemical storage practices can cause undesired chemical reactions, which may form hazardous products that can lead to employee exposure or possibly fires and property damage. All lab employees should carefully read each chemical's SDS and container label before deciding how to store a chemical, as these will often indicate any special storage requirements that may be necessary. The following subsections describe chemical storage requirements in more detail.

6.10 GENERAL CHEMICAL STORAGE

The following general chemical storage guidelines must be followed in all laboratories:

Each chemical in the laboratory must be stored in a specific location and returned there after each use. Acceptable chemical storage locations may include flammable cabinets, corrosive cabinets, laboratory shelves, or appropriate laboratory refrigerators or freezers.

Chemical containers must be in good condition and appropriate for the chemical that they contain and be free from exterior contamination.

Fume hoods should not be used as permanent chemical storage areas, unless designated as such. Not only does this create potentially unsafe conditions by having extraneous chemicals stored near chemical reactions and processes, excess chemical bottles in the hood may also seriously impair the ventilating capacity of the hood. Only chemicals being used in the process or experiment being conducted in the hood are allowed to be stored in the hood and should be removed when the process or experiment is complete.

Chemicals should not be permanently stored on bench tops. Avoid storing any chemical containers on the floor. Under no circumstance should chemical containers, or anything else, be stored in aisle ways, corridors, or in front of doors.

Hazardous liquids should not be stored on shelves above eye-level unless there is a SOP detailing safe handling procedures.

Chemicals should be stored at an appropriate temperature and humidity level and never be stored in direct sunlight.

Periodic cleanouts of expired or unneeded chemicals should be conducted to minimize the volume of hazardous chemicals stored in the laboratory.

Always follow the chemical manufacturer's storage instructions, if provided.

6.11 FLAMMABLE LIQUIDS STORAGE

Flammable liquids include any liquid with a flash point no greater than 93 °C (200 °F). The following guidelines for storing flammable liquids must be followed in all laboratories:

Flammable and combustible liquids should be stored in flammable storage cabinets as shown in Figure 6.1, whenever possible. No more than 10 gallons of flammable liquid is permitted to be stored outside of a flammable storage cabinet unless it is stored in a flammable safety can equipped with a spring-loaded lid and an internal screen as shown in Figure 6.2.

Domestic refrigerators or freezers must never be used to store flammable liquids. Flammable liquids can only be stored in refrigerators or freezers that are designed for flammable materials (most refrigerators are not intended for flammable storage).

Flammable liquids must be stored in well-ventilated areas free from ignition sources.

Some organic solvents (e.g., diethyl ether) have a shelf-life and can form organic peroxides over time while in storage. These "peroxide formers" must be dated when received from the chemical manufacturer and disposed of once expired. If any time-sensitive chemicals are found to be past the manufacturer's expiration date, AOPP must be notified for immediate hazardous waste disposal.

Figure 6.1 – Flammable Storage Cabinet **Figure 6.2 – Flammable Safety Can**

Compressed Gases Storage

Compressed gases are defined as gases that are contained in a receptacle at a pressure not less than 280 kPA at 20 °C or as a refrigerated liquid. The following guidelines for storing compressed gases must be followed in all laboratories:

Compressed gas cylinders (cylinders) must be stored in a secure, well ventilated location, and in an upright position at all times.

All cylinders should be handled as if full and should never be completely emptied.

Cylinders that are not in use (meaning that the cap is on) must be secured and have the safety cap. Multiple cylinders may be secured together (gang-chained), only if they are capped (not in use). Only capped cylinders can be secured with a single restraining device (gang chained) as shown in Figure 6.3.

Cylinders that are in use, meaning there is a regulator attached, must be individually secured by a chain or strap as shown in Figure 6.4. Cylinder valves and regulators should be protected from impact or damage.

Figure 6.3 – Not In-Use Cylinders **Figure 6.4 – In-Use Cylinders**

6.12 REACTIVE MATERIALS STORAGE

Reactive materials include explosives, pyrophorics, self-heating and self-reacting compounds, and water-reactive. Many reactive materials are also toxic and are dissolved or immersed in a flammable solvent (e.g., lithium alkyl compounds dissolved in diethyl ether, sodium metal immersed in mineral oil). Other common hazards often associated with reactive chemicals include corrosivity, teratogenicity, or organic peroxide formation. The following guidelines for storing reactive materials must be followed in all laboratories:

The amount of reactive materials stored in the lab must be kept to a minimum. Any expired or unnecessary reactive materials must be properly disposed of as hazardous waste.

All reactive materials must be clearly labeled with the original manufacturer's label, which should have the chemical name, hazard labels, and pictograms. The label should not be defaced in any way.

All reactive materials should be placed into secondary containment as a best management practice.

Suitable storage locations for reactive materials include inert gas-filled desiccators or glove boxes, flammable storage cabinets that do not contain aqueous or other incompatible chemicals, or intrinsically safe refrigerators or freezers that also do not contain aqueous or other incompatible chemicals. If possible, store all reactive chemicals in a small flammable cabinet dedicated only for reactive. Signs should be posted to indicate their presence and unique hazards as shown in Figure 6.5.

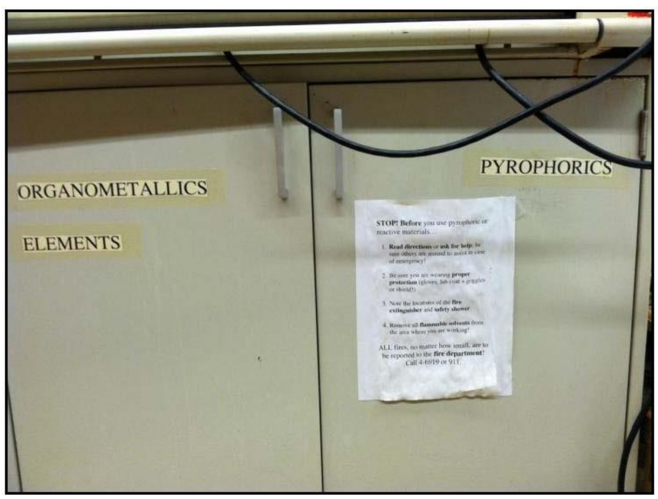


Figure 6.5 – Reactive Chemicals Storage

Many reactive materials are water and/or air reactive and can spontaneously ignite on contact with air and/or water. Therefore, reactive must be handled under an inert atmosphere and in such a way that rigorously excludes air and moisture.

If reactive materials are received in a specially designed shipping, storage, or dispensing container (such as the Aldrich Sure-Seal packaging system), ensure that the integrity of that container is maintained. Ensure that sufficient protective solvent, oil, kerosene, or inert gas Remains in the container while reactive materials are stored.

6.13 ACUTELY TOXIC MATERIALS STORAGE

Acutely toxic materials are defined as substances that may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration. The following guidelines for storing acutely toxic materials must be followed in all laboratories:

Suitable storage locations for acutely toxic materials include desiccators, glove boxes, flammable storage cabinets that do not contain incompatible chemicals (primarily strong acids), or non-domestic refrigerators or freezers. These locations should be clearly posted.

Acutely toxic materials should be stored in secondary containment at all times as a best management practice.

If possible, store all acutely toxic materials in a cabinet dedicated only for acutely toxic materials. Signs should be posted to indicate their presence and unique hazards.

The amount of acutely toxic material stored in the lab should be kept at a minimum.

Any expired or unnecessary materials must be properly disposed of as hazardous waste.

All acutely toxic materials should be clearly labeled with the original manufacturer's label, which should have the chemical name, hazard labels, and pictograms. The label should not be defaced in any way.

6.14 CORROSIVE MATERIALS STORAGE

Corrosive materials are defined as substances that cause destruction of living tissue by chemical corrosion at the site of contact and can be either acidic or basic (caustic). The best storage method for corrosive materials is inside of a corrosive storage cabinet or lab cabinet where acids and bases are segregated at all times. Acids must also be segregated from chemicals where a toxic gas would be generated upon contact with an acid (e.g., reactive cyanide compounds). Organic acids (e.g., acetic acid, formic acid) must be stored away from oxidizing acids (e.g., nitric acid, perchloric acid), as these types of acids are incompatible with each other. Segregation can be achieved either by physical distance (preferred method) or by secondary containment as shown in Figure 6.6.

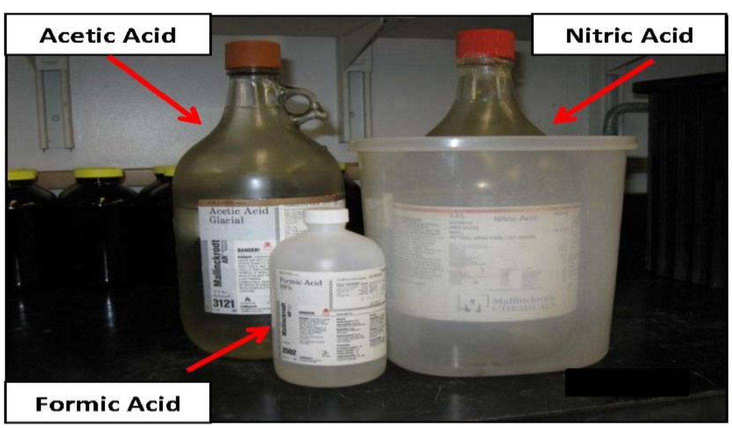


Figure 6.6 – Chemical Segregation Using Secondary Containment

6.15 OXIDIZERS AND ORGANIC PEROXIDE STORAGE

Oxidizing materials are defined as substances which, while in itself are not necessarily combustible, may generally by yielding oxygen, cause, or contribute to the combustion of other material. An organic peroxide is an organic substance which contains the bivalent -O-O- structure and may be considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals. The following guidelines for storing oxidizers and organic peroxides must be followed in all laboratories:

Oxidizers (e.g., hydrogen peroxide, sodium nitrate) and organic peroxides (e.g., methyl ethyl ketone peroxide, benzoyl peroxide) must be stored in a cool, dry location and kept away from combustible materials such as wood, pressboard, paper, and organic chemicals (e.g., organic solvents and organic acids).

If possible, store all strong oxidizing agents in a chemical cabinet dedicated only for oxidizers.

The amount of oxidizers and organic peroxides stored in the lab should be kept at a minimum.

All material must be clearly labeled; the original manufacturer's label with the chemical name, hazard labels, and pictograms should not be defaced or covered.

6.16 REFRIGERATORS AND FREEZERS CHEMICAL STORAGE

A number of general precautions need to be taken when storing chemicals in refrigerators and/or freezers in the laboratory. When working with freezers or refrigerators, the following procedures must be followed:

Domestic refrigerators or freezers must never be used to store flammable liquids. Flammable liquids are only allowed to be stored in refrigerators or freezers that are designed for flammable materials (most refrigerators are not intended for flammable storage).

Lab refrigerators or freezers must never be used to store food or beverages for consumption. Lab refrigerators/freezers should be posted with a sign that states "No Food or Drink".

All chemicals stored in a refrigerator or freezer must be labeled.

Ensure that the chemicals stored in a refrigerator or freezer is compatible with each other. For example, do not store an oxidizer such as hydrogen peroxide in a refrigerator with organic chemicals.

There must not be any open chemicals in a refrigerator or freezer. All containers must be completely sealed or capped and safely stored.

Chemicals should be allowed to warm to room temperature before sealing to prevent pressure buildup.

Shelves in refrigerators or freezers should all have suitable plastic trays for secondary containment in the refrigerator and freezer compartments. If plastic trays are not available, liquid chemicals should be placed in secondary containers to contain spills.

Remember that power outages and technology failures can cause internal temperatures to rise, which can impact chemical contents. Be aware of unusual odors, vapors, etc., when opening the refrigerator or freezer.

An inventory should be posted on the refrigerator door.

Chemical refrigerator or freezers should be located away from laboratory exits.

Refrigerators and freezers should be cleaned-out and manually defrosted as necessary.

When defrosting a freezer, consideration should be taken regarding potential chemical contamination of the water. If the water draining from a defrosted refrigerator may be chemically contaminated, contact AOPP for further assistance.

6.17 COMPRESSED GAS CYLINDER SAFETY

Compressed gas storage requirements are discussed above in Section 5.7.3. However, there are additional important safety requirements for use of compressed gases in laboratories detailed below:

Gas cylinder connections and fittings must be inspected frequently for deterioration.

Never use a leaking, corroded, or damaged cylinder and never refill compressed gas cylinders.

When stopping a leak between cylinder and regulator, always close the valve before tightening the union nut.

The regulator must be replaced with a safety cap when the cylinder is not in use.

The safety cap must be in place when a gas cylinder is moved. For large gas cylinders (>27 inches), an approved gas cylinder cart should be used.

The cylinder must be strapped to the cart and the protective cap must be in place before moving the cylinder. A cylinder should never be moved or transported without the protective cap. The proper way to move a large gas cylinder is illustrated in Figure 6.7.

Figure 6.7 – Gas Cylinder Cart

Never dispense from a cylinder if it is on a gas cylinder cart.

A few compressed gas cylinders have a shelf-life and can become more hazardous as time goes on. It is extremely important that these chemicals are identified and managed properly. If any time-sensitive gases are found to be past the manufacturer's expiration date, they must be submitted to AOPP for hazardous waste disposal immediately. The following is a list of time-sensitive compressed gases:

- Hydrogen Fluoride, anhydrous
- Hydrogen Bromide, anhydrous
- Hydrogen Sulfide, anhydrous
- Hydrogen Cyanide, anhydrous
- Hydrogen Chloride, anhydrous

The compressed gases listed above have a shelf-life provided by the manufacturer that must be strictly followed. There have been numerous incidents involving these compounds related to storage past the expiration date. For example, hydrogen fluoride (HF) and hydrogen bromide (HBr) cylinders have a shelf-life of one to two years, depending on the vendor. Over time, moisture can slowly enter the cylinder, which initiates corrosion. As the corrosion continues, HF and/or HBr slowly react with the internal metal walls of the cylinder to produce hydrogen. The walls of the cylinder weaken due to the corrosion, while at the same time the internal pressure increases due to the hydrogen generation. Ultimately, these cylinders fail and create extremely dangerous projectiles and a toxic gas release.

6.18 CRYOGENIC LIQUIDS SAFETY

A cryogenic liquid is defined as a liquid with a normal boiling point below -150 °C (-240 °F). The most common cryogenic liquid used in a laboratory setting is liquid nitrogen. By definition, all cryogenic liquids are extremely cold. Cryogenic liquids and their vapors can rapidly freeze human tissue and can also pose an asphyxiation hazard if handled in confined spaces. The following precautions should be taken when handling cryogenic liquids:

Use and store cryogenic liquids in well ventilated areas only.

Wear appropriate PPE while handling cryogenic liquids. Proper PPE for handling cryogenic liquids includes chemical splash goggles, a face shield, cryogenic-safe gloves, long sleeves, long pants, and closed-toe shoes.

Cryogenic liquids will vent (boil off) from their storage containers as part of normal operation. Containers are typically of a vacuum jacketed design to minimize heat loss. Excessive venting and/or an isolated ice build-up on the vessel walls may indicate a fault in the vessel's integrity or a problem in the process line. A leaky container should be removed from service and taken to a safe, well-ventilated area immediately.

All systems components piping, valves, etc., must be designed to withstand extreme temperatures.

Pressure relief valves must be in place in systems and piping to prevent pressure buildup. Any system section that could be valved off while containing cryogenic liquid must have a pressure relief valve. The pressure relief valve relief ports must be positioned to face toward a safe location.

Transfer operations involving open cryogenic containers, must be done slowly, and while wearing all required PPE. Care must be taken not to contact non-insulated pipes and system components.

Open transfers will be allowed only in well-ventilated areas.

Do not use a funnel while transferring cryogenic liquids.

Use tongs or other similar devices to immerse and remove objects from cryogenic liquids; never immerse any part of your body into a cryogenic liquid.

6.19 NANOPARTICLE SAFETY

The American Society of Testing and Materials (ASTM) Committee on Nanotechnology has defined a nanoparticle as a particle with lengths in two or three dimensions between 1 and 100 nanometers (nm). Nanoparticles can be composed of many different base materials and may be of different shapes including: nanotubes, nanowires, and crystalline structures such as fullerenes and quantum dots. Nanoparticles present a unique challenge from an occupational health perspective as there is a limited amount of toxicological data currently available for review. However, some studies have shown that existing exposure control technologies have been effective in reducing exposure to nanoparticles

6.20 SHARPS HANDLING SAFETY

Sharps are defined as items capable of puncturing, cutting, or abrading the skin such as glass or plastic pipettes, broken glass, test tubes, petri dishes, razor blades, needles, and syringes with needles. Sharps are often contaminated with hazardous chemicals and/or infectious agents, so multiple hazards are often encountered. Employees that routinely work with sharps must be aware of the risk of being punctured or lacerated. It is important for these employees to take precautions and properly handle sharps in order to prevent injury and potential disease transmission. These employees should use appropriate PPE (e.g., puncture-resistant gloves), tools, barrier protection, sharps waste containers, and engineering controls to protect themselves.

6.21 EQUIPMENT, APPARATUS, AND INSTRUMENT SAFETY

Centrifuges

The following safety guidelines should be followed when operating centrifuges:

Before centrifugation:

- Centrifuges must be properly installed and operated only by trained personnel;
- Centrifuges cannot be placed in the hallway of a building; they must remain inside of the laboratory;
- Train each operator on proper operating procedures, review the user manual.

- Use only rotors compatible with the centrifuge. Check the expiration date for ultracentrifuge rotors;
- Check tubes, bottles, and rotors for cracks and deformities before each use;
- Make sure that the rotor, tubes, and spindle are dry and clean;
- Examine O-rings and replace if worn, cracked, or missing;
- Never overfill centrifuge tubes (don't exceed ¾ full);
- Always cap tubes before centrifugation;
- Always balance buckets, tubes, and rotors properly;
- Check that the rotor is seated on the drive correctly, close the lid on the centrifuge, and secure it; and
- When using swinging bucket rotors, make sure that all buckets are hooked correctly and move freely.

During centrifugation:

- Close lids at all times during operation. Never open a centrifuge until the rotor has stopped;
- Do not exceed safe rotor speed;
- The operator should not leave the centrifuge until full operating speed is attained and the machine appears to be running safely without vibration; and
- Stop the centrifuge immediately if an unusual condition (noise or vibration) begins and check load balances.

After centrifugation:

- Allow the centrifuge to come to a complete stop before opening;
- Wear new pair of outer gloves to remove rotor and samples;
- Check inside of centrifuge for possible spills and leaks, clean centrifuge and rotor thoroughly if necessary; and
- Wash hands after removing gloves.

Stirring and Mixing Equipment

Stirring and mixing devices commonly found in laboratories include stirring motors, magnetic stirrers, and shakers. These devices are typically used in lab operations that are performed in a chemical fume hood, and it is important that they be operated in a way that prevents the generation of electrical sparks. Only spark-free induction motors should be used in power stirring and mixing devices or any other rotating equipment used for laboratory operations. Because stirring and mixing devices, especially stirring motors and magnetic stirrers, are often operated for fairly long periods without constant attention, the consequences of stirrer failure, electrical overload or blockage of the motion of the stirring impeller should be considered.

Heating Devices

Laboratories commonly use heating devices such as ovens, hot plates, heating mantles, oil baths, salt baths, sand baths, air baths, hot-tube furnaces, hot-air guns, and microwave ovens. Steam heated devices are generally preferred whenever temperatures of 100 °C or less are required because they do not present shock or spark risks and can be left unattended with assurance that their temperature will never exceed 100 °C. Ensure the supply of water for steam generation is sufficient prior to leaving the reaction for any extended period of time.

A number of general precautions need to be taken when working with heating devices in the laboratory. When working with heating devices, consider the following:

- The actual heating element in any laboratory heating device should be enclosed in such a fashion as to prevent a laboratory worker or any metallic conductor from accidentally touching the wire carrying the electric current;
- If a heating device becomes so worn or damaged that its heating element is exposed, the device should be either discarded or repaired before it is used again;
- The external cases of all variable autotransformers have perforations for cooling by ventilation and, therefore, should be located where water and other chemicals cannot be spilled onto them and where they will not be exposed to flammable liquids or vapors; and
- Fail-safe devices can prevent fires or explosions that may arise if the temperature of a reaction increases significantly because of a change in line voltage, the accidental loss of reaction solvent, or loss of cooling. Some devices will turn off the electric power if the temperature of the heating device exceeds some preset limit or if the flow of cooling water through a condenser is stopped owing to the loss of water pressure or loosening of the water supply hose to a condenser.

<u>Distillation and Solvent Purification Systems</u>

The process of thermal solvent distillation is inherently dangerous. If not handled properly, fire, explosion, and/or personnel exposure can result. A few common chemicals distilled in laboratories include tetrahydrofuran, methylene chloride, diethyl ether, toluene, dimethylformamide, benzene, and hexanes. The guidelines below should be followed while thermal distillation of organic solvents is conducted in the lab:

1. The thermal solvent distillation system should be installed inside of a chemical fume hood if possible.
2. Ensure that all heat generating equipment has a shut-off device installed.
3. Ensure that all water connections on the condenser are clamped securely.
4. Inspect all glassware for defects before setting them up in the experiment.
5. Keep all air and water-sensitive drying agents under inert atmosphere. Make consistent efforts to not store or use other flammable or hazardous chemicals inside the fume hood where distillation is taking place.

<u>Laboratory Glassware</u>

Broken laboratory glassware is dangerous. Glassware-related injuries ranging from small cuts to multiple stitches and eye damage are common to lab workers. In order to reduce the risk of accidents, the following guidelines should be followed:

1. Temperature changes can shatter any laboratory glassware. Never flash-cool glassware with cold water, especially after autoclaving or exposure to any high temperatures.
2. Only round-bottomed or thick-walled (e.g., Pyrex) evacuated reaction vessels specifically designed for operations at reduced pressure should be used.
3. Inspect glassware for any small imperfections before using. Sometimes a hairline crack may be present. Tap the glassware with a pen and listen to the tone to tell if there is a defect. A ringing tone indicates the glassware is fine, while a dull “thud” indicates there is a flaw present.
4. Don’t keep cracked glassware. If the bottom of a graduated cylinder is chipped or broken, properly dispose of it.
5. Always wear appropriate PPE when working with glassware and varying temperatures. Always wear safety glasses.

High Pressure Systems

1. Working with high pressure systems in a laboratory can result in over-pressurization, explosion, and the possible hazards of flying glass, chemical exposure, and fire. All high pressure systems must be set up and operated with careful consideration of potential risks. The following procedures should be followed when working with high pressure systems in the laboratory;
2. High-pressure operations should be performed only in pressure vessels appropriately selected for the operation, properly labeled and installed, and protected by pressure-relief control devices;
3. Vessels, connecting hoses, and any apparatus must be strong enough to withstand the stresses encountered at the intended operating temperatures and pressures and must not corrode or otherwise react when in contact with the materials it contains; and
4. All pressure equipment should be visually inspected before each use.

Vacuum Systems

Vacuum work can result in an implosion and the possible hazards of flying glass, splattering chemicals, and fire. All vacuum operations must be set up and operated with careful consideration of the potential risks. The following guidelines should be followed when using vacuum apparatus in the laboratory:

1. Do not allow water, solvents, or corrosive gases to be drawn into vacuum systems. Protect pumps with cold traps and vent their exhaust into an exhaust hood.
2. Assemble vacuum apparatus in a manner that avoids strain, particularly to the neck of the flask.
3. Avoid putting pressure on a vacuum line to prevent stopcocks from popping out or glass apparatus from exploding.
4. Place vacuum apparatus in such a way that the possibility of being accidentally hit is minimized. If necessary, place transparent plastic around it to prevent injury from flying glass in case of an explosion.
5. When using a rotary evaporator, the glass components of the rotary evaporator should be made of Pyrex or similar glass. Glass vessels should be completely enclosed in a shield to

guard against flying glass should the components implode. Increase in rotation speed and application of vacuum to the flask whose solvent is to be evaporated should be gradual.

When using a vacuum source, it is important to place a trap between the experimental apparatus and the vacuum source. The vacuum trap protects the pump and the piping from the potentially damaging effects of the material, protects people who must work on the vacuum lines or system, and prevents vapors and related odors from being emitted back into the laboratory or system exhaust. The following vacuum trapping guidelines should be followed:

1. Make sure the flask is properly clamped and secured;
2. Make sure the vacuum hose is connected to the vacuum line, not the gas line;
3. To prevent contamination, all lines leading from experimental apparatus to the vacuum source should be equipped with filtration or other trapping device as appropriate;
4. For particulates, use filtration capable of efficiently trapping the particles in the size range being generated;
5. For most aqueous or non-volatile liquids, a filter flask at room temperature is adequate to prevent liquids from getting to the vacuum source;
6. For solvents and other volatile liquids, use a cold trap of sufficient size and cold enough to condense vapors generated, followed by a filter flask capable of collecting fluid that could be aspirated out of the cold trap; and
7. For highly reactive, corrosive, or toxic gases, use a sorbent canister or scrubbing device capable of trapping the gas.

Research Samples and Chemicals Developed in the Lab

Research samples and chemicals developed in the lab (samples) must be managed responsibly. Samples often accumulate in labs for years and are difficult to identify and dispose of and can create unsafe and non-compliant conditions if not managed properly. The following requirements apply to samples developed in the laboratory:

1. All samples must be kept closed except when in use;
2. Storage in beakers or flasks should be temporary. If temporarily storing samples in beakers or flasks, a cork, Parafilm®, or some other closure device must be used;
3. All samples must be labeled with the chemical name, date the sample was developed/received, and the name of generator;
4. Chemical structure or a labeling system that is only known to lab personnel is not acceptable as the only means of labeling samples. Acronyms can be used as a labeling system as long as an up-to-date legend is posted in the lab;
5. Samples should be disposed of within 6 months unless actively being used for analysis. Stockpiling unusable samples in not an acceptable practice. All samples that are no longer necessary must be properly disposed of in a timely manner using AOPP’s hazardous waste program; and
6. Samples must be stored according to the primary hazard class; this should be done to the best of your ability considering the properties that are known or assumed such as toxicity.

If the hazard(s) of a sample are unknown, the Laboratory Supervisor must attempt to determine whether it is hazardous or not. Assume all samples are toxic unless otherwise demonstrated. This can be accomplished by literature review or reviewing the hazards of other similar compounds. At a minimum, the Laboratory Supervisor should be able to determine if a chemical is flammable, corrosive, oxidant, or reactive. If samples are consolidated for storage (e.g., vial boxes), it is not always necessary to label every sample container. For example, a box containing sample vials which are all in the same hazard class (e.g., miscellaneous pharmaceutical compounds considered to be toxic) can have one label on the outside of the box stating “Miscellaneous Toxic Pharmaceutical Compounds” or a similar description. A label such as the one shown in Figure 5.9 can be used to identify consolidated samples, and should only be used on a temporary basis. This type of information communicates the hazards to emergency responders, as well as gives AOPP the information necessary for proper disposal.

If the chemical substance is produced for another user outside of the lab, the Laboratory Supervisor must comply with the Hazard Communication Standard including the requirements for preparation of SDSs and container labeling.

Transporting Hazardous Chemicals

Transporting chemicals is a potentially hazardous process that must be done properly to avoid accidents and potential injuries. The following subsections discuss how to properly ship chemical off campus using a shipping company, how to transport chemicals on campus using a SCU-owned vehicle, and how to safely move chemicals by foot across campus.

Shipping Hazardous Chemicals off Campus

Shipping chemicals, research samples, or other similar materials off campus is potentially regulated by the Department of Transportation (DOT) and/or other regulatory agencies. Chemicals regulated for shipping require very specific types of packaging, labeling, and documentation and must be prepared by trained personnel. AOPP makes the determination on whether a chemical is classified as hazardous for transportation purposes. Unless the researcher is DOT trained, they are not authorized to make this determination. Shipments that are not prepared by trained personnel can result in delays, loss of research samples, and potential regulatory fines. AOPP is the only authorized department at SCU that may arrange for a hazardous chemical to be shipped off site.

Transporting Chemicals on Campus via SCU Vehicle

When transporting chemicals on campus all chemical containers must be properly packaged, labeled, and segregated according to hazard class. Do not attempt to move large volumes (e.g., greater than 5 gallons in total volume) of chemicals across campus. If a large volume of chemicals needs to be moved across campus, such as an entire lab move, contact AOPP for further assistance. The following procedures must be followed in order to properly and legally transport chemicals across campus:

Only SCU-owned vehicles are permitted to be used to transport chemicals. For liability and insurance purposes, no personal vehicles should ever be used to transport hazardous chemicals.

Ensure that each container has an appropriate, tight fitting lid. The lid should have the ability to contain the contents of the container even if it becomes inverted during transport. Examples of inappropriate lids include cracked caps, loosely fitting rubber stoppers, or Parafilm®.

Chemicals should be segregated according to the primary hazard class. For example, do not place an oxidizer such as ammonium nitrate in the same container as an organic solvent such as acetone.

All containers should be packaged upright.

Chemical containers should be placed in some type of outer packing such as a box, bin or bucket. Containers should remain securely packaged during loading, transport, and unloading. Glass to glass contact should be avoided. Bubble wrap, newspaper, and vermiculite are good examples of packaging material that will prevent glass to glass contact.

The outer containers should remain tightly secured during transport. Measures should be taken to avoid movement of the outer containers. For example, the containers should be secured using a strap or an empty box can be used to fill the gap between the last box and the sidewall of the vehicle.

The outer container must be labeled in a manner that identifies the contents (e.g. corrosives, flammables).

Transport with two or more people if possible.

Be prepared for unseen accidents. At least one person should be knowledgeable of the materials being transported. An inventory with an estimated volume or weight per hazard should be recorded and available during transport (e.g., 5 gallons of flammable liquid and 10 pounds of toxic solids).

Prepare a spill kit prior to transport. Material such as appropriate PPE, absorbent material, and an empty bucket is sufficient for most small spills.

Carry a cell phone and know who to call 911 in the event of an emergency.

<u>Transporting Chemicals on Campus via Foot</u>

Transporting small volumes of chemicals across campus via foot (e.g., from two neighboring campus buildings) is acceptable as long as it is done properly. Do not attempt to move large volumes (e.g., greater than 5 gallons in total volume) of chemicals across campus via foot. If a large volume of chemicals needs to be moved, such as an entire lab move, contact AOPP for further assistance. The following procedures must be followed when moving chemicals on campus by way of foot:

PPE must be worn when handling potentially contaminated surfaces. During the time which the chemicals are moved on campus via foot, PPE may not be necessary or even appropriate (e.g., employees should not wear chemical-resistant gloves in public areas). However, appropriate PPE and spill containment equipment should be brought along in the event of a spill or incident.

SCU personnel shall not dispense or sell chemicals in breakable containers of any size unless the customer has an approved transport container in which to place the chemical for transportation. Approved transport container means a commercially available bottle carrier made of rubber, metal, or plastic with carrying handle(s) which is large enough to hold the contents of the container if broken in transit. Carrier lids or covers are recommended, but not required. Rubber or plastic should be used for acids/alkalis; and metal, rubber, or plastic for organic solvents.

Laboratory carts can be used to transport chemicals from one area to another as long as they are stable and in good condition. Transport only a quantity which can be handled easily. Plan the route ahead of time so as to avoid all steps or stairs.

Freight elevators, not passenger elevators, should be used to transport hazardous chemicals whenever possible. The individual transporting the hazardous chemicals should operate the elevator alone if possible. Avoid getting on an elevator when a person is transporting hazardous chemicals.

Laboratory Self-Inspections

AOPP performs laboratory inspections for various purposes (e.g., routine building safety and compliance inspections). However, the Laboratory Supervisor - a qualified designee - should also inspect the laboratory for compliance with the requirements of the CHP at a minimum on a monthly basis. Lab personnel have a much greater understanding of the unique hazards and issues that are encountered in their individual lab than AOPP does. The goal of these inspections is to identify and correct unsafe and non-compliant conditions that could potentially result in an injury to lab personnel or a fine from a regulatory agency (e.g., open hazardous waste container). All deficiencies found during the inspection should be reviewed and corrected. The following elements should be performed during these inspections:

Housekeeping practices should be reviewed. Chemicals should be stored appropriately and labeled. Evidence of spills and/or chemical contamination should be cleaned. All glassware and equipment should be stored appropriately, etc.

Hazard assessments should be updated if process changes have occurred. For example, the lab is now performing organic synthesis and working with organic metallic compounds.

Training records should be updated and documented if new lab personnel have not yet been trained or if any processes have changed.

Excess or outdated chemicals should be properly labeled and stored in the appropriate container. AOPP should then be notified to schedule proper disposal.

Safety supplies such as PPE and spill containment equipment should be replenished if necessary.

Laboratory Ergonomics

Many tasks in laboratories require repetitive motions which may lead to cumulative trauma injuries of the body, these effects can be long term. Tasks like pipetting, weighing multiple samples, standing at the bench or hood and using microscopes for long periods of time can cause physical stress. Even time compiling data at a computer poses potential physical problems. Ergonomics is the study of interaction of the human body with the work environment. Ergonomics strives to fit the job to the body through proper body positioning, posture, movement, tools, workplace layout and design. Parts of the body commonly affected by poor ergonomics include: neck, shoulders, back, hands, wrists, elbows, legs, and feet.

Resources are available to improve ergonomic conditions and help reduce cumulative trauma injuries to laboratory workers. Often simple adjustments are all that is required to improve conditions. Contain AOPP for more information.

Laboratory Electrical Safety

Training

Laboratory employees shall be trained to understand the specific hazards associated with electrical energy.

Employees who need access to operate circuit breakers and fused switches in electrical panels may require additional training to be designated by their supervisor as qualified for the task.

Portable Electrical Equipment and Extension Cords

The following requirements apply to the use of cord-and-plug-connected equipment and flexible cord sets (extension cords):

Extension cords may only be used to provide temporary power and must be used with Ground Fault Circuit Interrupter (GFCI) protection during maintenance and construction activities and in damp or wet locations.

Portable cord and plug connected equipment and extension cords must be visually inspected before use for external defects such as loose parts, deformed and missing pins, or damage to outer jacket or insulation, and for possible internal damage such as pinched or crushed outer jacket. Any defective cord or cord-and-plug-connected equipment must be removed from service and no person may use it until it is repaired and tested to ensure it is safe for use.

Extension cords must be of the three-wire type. Extension cords and flexible cords must be designed for hard or extra hard usage. The rating or approval must be visible.

Portable equipment must be handled in a manner that will not cause damage. Flexible electric cords connected to equipment may not be used for raising or lowering the equipment.

Extension cords must be protected from damage. Sharp corners and projections must be avoided. Flexible cords may not be run through windows or doors unless protected from damage, and then only on a temporary basis. Flexible cords may not be run above ceilings or inside or through walls, ceilings or floors, and may not be fastened with staples or otherwise hung in such a fashion as to damage the outer jacket or insulation.

Extension cords used with grounding type equipment must contain an equipment-grounding conductor; the cord must accept a three-prong, or grounded, plug. Operating equipment with extension cords without a grounding plug is prohibited.

Attachment plugs and receptacles may not be connected or altered in any way that would interrupt the continuity of the equipment grounding conductor. Additionally, these devices may not be altered to allow the grounding pole to be inserted into current connector slots. Clipping the grounding prong from an electrical plug is prohibited.

Flexible cords may only be plugged into grounded receptacles. Adapters that interrupt the continuity of the equipment grounding connection may not be used.

All portable electric equipment and flexible cords used in highly conductive work locations, such as those with water or other conductive liquids, or in places where employees are likely to contact water or conductive liquids, must be approved for those locations.

Employee's hands must be dry when plugging and unplugging flexible cords and cord and plug connected equipment if energized equipment is involved.

If the connection could provide a conducting path to the employee’s hands (e.g. if a cord connector is wet from being immersed in water), the energized plug and receptacle connections must be handled only with insulating protective equipment.

Lamps for general illumination must be protected from breakage, and metal shell sockets must be grounded.

Temporary lights must not be suspended by their cords unless they have been designed for this purpose.

Extension cords are considered to be temporary wiring, and must also comply with the section on “Requirements for Temporary Wiring” in this program. All use of extension cords must be approved by Physical Plant Management.

Temporary Wiring Requirements

Temporary electrical power and lighting installations 600 volts or less, including flexible cords, cables and extension cords, may only be used during and for renovation, maintenance, repair, or experimental work. The following additional requirements apply:

Ground-fault protection (e.g. GFCI) must be provided on all temporary-wiring circuits, including extension cords, used for construction or maintenance activities.

In general, all equipment and tools connected by cord and plug must be grounded. Listed or labeled double insulated tools and appliances need not be grounded.

Receptacles must be of the grounding type.

Flexible cords and cables must be of an approved type and suitable for the location and intended use. They may not be used as a substitute for the fixed wiring, where run through holes in walls, ceilings or floors, where run through doorways, windows or similar openings, where attached to building surfaces, or where concealed behind building walls, ceilings, floors, rugs or carpeting .

Suitable disconnecting switches or plug connects must be installed to permit the disconnection of all ungrounded conductors of each temporary circuit.

Lamps for general illumination must be protected from accidental contact or damage, either by elevating the fixture above 8 feet above the floor or other working surface or by providing a suitable guard. Hand lamps supplied by flexible cord must be equipped with a handle of molded composition or other approved material and must be equipped with a substantial bulb guard.

Flexible cords and cables must be protected from accidental damage. Sharp corners and projections are to be avoided. Flexible cords and cables must be protected from damage when they pass through doorways or other pinch points.

Wet or Damp Locations

Work in wet or damp work locations (i.e., areas surrounded or near water or other liquids) should not be performed unless it is absolutely critical. Electrical work should be postponed until the liquid can be cleaned up. The following special precautions must be incorporated while performing work in damp locations:

- Only use electrical cords that have GFCIs;
- Place a dry barrier over any wet or damp work surface;
- Remove standing water before beginning work. Work is prohibited in areas where there is standing water;
- Do not use electrical extension cords in wet or damp locations; and
- Keep electrical cords away from standing water.

7. LABORATORY PPE POLICY

Purpose

The purpose of this Laboratory Personal Protective Equipment (PPE) Policy is to ensure that all SCU lab employees are aware of the PPE requirements and procedures to adequately protect themselves against chemical, radiological, biological, or mechanical hazards. This policy has been prepared in accordance with the requirements of the OSHA PPE regulations (29 CFR 1910.132 - 29 CFR 1910.140, 29 CFR 1910.95). As briefly discussed in Chapter 4 of the CHP, PPE should never be used in place of engineering and administrative controls.

Scope

This Laboratory PPE Policy applies to all personnel that work with or around hazardous chemicals or other safety and health hazards. This Laboratory PPE Policy does not cover all potential hazards (e.g., confined space entry, welding operations, and high voltage) in all operations or settings. If an instructor encounters hazards not covered in this Laboratory PPE Policy, contact AOPP for assistance. Instructors are required to wear the applicable PPE when present inside labs and are further required to ensure that students and visitors are wearing the appropriate PPE as well.

PPE is assigned based on the specific function (experiment, exercise, cleaning, etc.) being performed inside the lab. If a specific experiment or exercise being performed inside any given lab requires more than the basic PPE laid out in this document, it is the responsibility of the instructor to ensure that the appropriate PPE is utilized.

For purposes of this document, “instructor” means lead instructor, assisting instructor, student teaching assistant, lab technician, and chief lab technician.

7.1 HAZARD ASSESSMENT

The hazard assessment is a process of identifying the hazards associated with a defined task, and prescribing PPE along with other relevant protection measures that must be employed to minimize the risk from the hazards. Hazard assessments are performed by completing a certification of hazard assessment, which is a written document detailing the hazard assessment process for defined tasks. The Laboratory Supervisor is responsible for ensuring that hazard assessments are performed and the certification(s) is written, signed, dated, and readily available or posted in each location. The Laboratory Supervisor is also responsible for ensuring that all lab personnel receive documented training on applicable hazard assessments. The certification of hazard assessment should be reviewed at least annually and updated any time a process is modified or when a new task which presents a hazard is introduced into the lab.

Hazard assessments can be organized using three formats: by individual task (e.g., pipetting hazardous liquids), by location (e.g., Chemistry Laboratory Room), or by job title (e.g., Chemistry Lab Technician). Any of these formats is acceptable and often will be used in conjunction with each other to provide the safest laboratory work environment possible for employees. The following subsections describe each hazard assessment format in more detail.

7.2 TASK EVALUATION HAZARD ASSESSMENT

Task evaluation hazard assessments should be conducted for specific tasks such as preparing dilute hydrochloric acid solutions or an ozonolysis reaction and workup. These types of hazard assessments should be written in a very detailed manner. The following describes the steps that should be taken to perform a task evaluation hazard assessment:

- Describe the task.
- List hazards associated with each body part.
- Determine PPE requirements for each hazard.
- List other control measures required such as engineering and administrative controls.

7.3 LOCATION EVALUATION HAZARD ASSESSMENT

Location evaluation hazard assessments should be conducted for specific areas/laboratories. These types of hazard assessments should be written in a comprehensive manner that includes the majority of hazards present in a specific location (e.g., flammable and corrosive liquids). This type of hazard assessment is the most commonly used in laboratories and should be posted in a location within the lab where it is easily accessed by personnel (e.g., posted near the front door of the lab). If employees perform specific tasks not covered by the laboratory hazard assessment, then it will be necessary to perform another type of hazard assessment such as the task evaluation assessment that does address the specific hazards of that task. The following describes the steps that should be taken to perform a task evaluation hazard assessment:

- Identify the hazards;
- List each task where hazard is present;
- Determine PPE requirements for each task; and
- List other control measures required engineering and administrative controls.

7.4 JOB TITLE EVALUATION HAZARD ASSESSMENT

Job title evaluation hazard assessments should be conducted for specific positions. These types of hazard assessments should be written in a comprehensive manner that includes the majority of hazards that a specific job position (e.g., Animal Care Technician) routinely encounters during the normal course of work. This type of hazard assessment is commonly used for positions where the hazards encountered do not frequently change. If the employee encounters a hazard that is not covered by the job title evaluation hazard assessment, then it will be necessary to perform another type of hazard assessment such as the task evaluation hazard assessment that does address the specific hazards of that task. The following describes the steps that should be taken to perform a task evaluation hazard assessment:

- Identify hazards that the position title may encounter while performing normal duties;
- List each task where hazard is present;
- Determine PPE requirements for each task; and
- List other control measures required.

7.5 MINIMUM PPE REQUIREMENTS FOR LABORATORIES

This section details the minimum PPE requirements for all laboratories using hazardous chemicals. These requirements do not apply to labs that involve solely mechanical, computer, laser or other non-ionizing radiation, or electrical operations. The requirements listed do not cover all operations in all laboratories. Some operations and procedures may warrant further PPE, as indicated by the SDS, the SOP for the chemical(s) being used, facility policies, hazard assessment, or regulatory requirements. In order to further minimize the potential of a safety risk or exposure to students and employees, exams, quizzes, and tests that do not require the use of laboratory equipment shall be scheduled to take place at non-lab locations (classrooms).

Appendix E illustrates the minimum PPE required while inside the specific labs present on campus.

Head Protection

If there is a serious risk of chemical splash to the head, a chemical-resistant hoodie must be worn. Each affected employee and student must wear protective helmets when working in areas where there is a potential for injury to the head from falling objects or “bump” hazards.

Hearing Protection

Hearing protection is not typically required in laboratory settings. However, if the lab seems excessively noisy (e.g., operating equipment that is loud, air handling unit is loud) and it is difficult to communicate with co-workers while in the lab, contact AOPP for a noise level evaluation.

Respiratory Protection

The use of respirators in the laboratory setting is not typically necessary since all work involving hazardous materials must be conducted in a chemical fume hood whenever possible. When ventilation is not adequate to provide protection against an inhalation hazard, respiratory protective equipment may be necessary. There is a variety of respiratory protective equipment available for use, but no one device will provide protection against all possible hazards. Respirator selection is based on the chemical and process hazard, and the protection factors required. Respirators are not to be used except in conjunction AOPP's "Respiratory Protection Program". This program includes a review of the process to ensure that proper equipment is selected for the job, training of all respiratory protective equipment users concerning the methods for proper use and care of such equipment, fitting of respirator users when required, and medical surveillance of respirator users when required. Respirators fitted with formaldehyde filters are assigned to each anatomy lab faculty and must be worn when entering the cold storage freezer or when scheduled to spend more than seven (7) hours inside the lab.

Eye and Face Protection

Each affected employee and student must use appropriate eye and face protection equipment when exposed to hazards from chemical splash, flying debris, or other exposures that may occur in the laboratory. Safety glasses must be worn at all times by all individuals that are occupying the anatomy laboratory area. Splash-proof safety goggles and/or a face shield are required for the microbiology and chemistry labs and may be more appropriate depending on the type of work being performed (e.g., transferring hazardous liquids outside of a chemical fume hood or glove box). All eye protection equipment must be American National Standards Institute (ANSI) approved and appropriate for the work being done. Prescription eyewear, sunglasses, or the like do not qualify as safety glasses or goggles. Students and employees must wear the approved safety glasses or goggles. See Appendix E for the approved PPE.

Hand Protection

Each affected employee and student must wear appropriate hand protection when their hands may be exposed to skin contact of hazardous chemicals, cuts, abrasions, punctures, or harmful temperature extremes. Chemical-resistant gloves must be worn while handling any hazardous chemical container; regardless of whether the container is open or closed (it should be assumed that all chemical containers are contaminated). When selecting appropriate gloves, it is important to evaluate the effectiveness of the glove type to the specific hazardous chemical being handled. Some gloves are more suitable for certain hazardous chemicals than others. The SDS for the specific chemical being handled and the glove manufacturer's glove chart should be consulted to select the most appropriate glove. Do not purchase gloves from a manufacturer that does not provide an adequate glove chart. It is recommended that each lab purchase a general purpose disposable nitrile glove (nitrile gloves are typically more versatile and provide resistance to a wider range of chemicals than latex gloves do) with a minimum of a 4 mil thickness that is suitable for general chemical handling. When handling chemicals with harmful temperature extremes such as liquid nitrogen or autoclaves, appropriate protection such as cryogenic gloves or heat-resistant gloves must be worn.

The volume of hazardous chemical being handled should be considered as well. For example, if working with a small volume of a sodium hydroxide solution, disposable chemical-resistant gloves provide adequate protection. But if working with a large volume of sodium hydroxide as with a base bath for instance, a more durable glove such as a butyl rubber should be selected to provide adequate protection.

Chemical-resistant gloves must not be worn outside of the laboratory (e.g., hallways, elevators, offices) to avoid contamination of public areas. Gloves should also be removed prior to handling any equipment that could likely result in cross-contamination (e.g., water fountains, telephones, computer work stations). Disposable gloves must never be reused and once soiled should be immediately disposed of and new gloves should be donned before transitioning to a different activity.

Body Protection

Each affected employee must wear protective clothing to protect the body from recognized hazards. All unprotected skin surfaces that are at risk of injury should be covered. Full length pants or full-length skirt must be worn at all times by all individuals that are occupying the laboratory area; shorts are not permitted. Lab coats, coveralls, aprons, or protective suits are required to be worn while working on, or adjacent to, all procedures using hazardous chemicals (e.g., chemical bottle is open and the chemical is being poured, transferred, pipetted, etc.). Laboratory coats must be appropriately sized for the individual and be fastened (snap buttons are recommended) to their full length. Laboratory coat sleeves must be of a sufficient length to prevent skin exposure while wearing gloves. Flame resistant laboratory coats must be worn when working with pyrophoric materials or flammable liquids greater than 1 liter in volume. It is recommended that 100% cotton (or other non-synthetic material) clothing be worn during these procedures to minimize injury in the case of a fire emergency.

Laboratory coats should not be worn outside of a laboratory unless the individual is traveling directly to an adjacent laboratory work area. Laboratory coats should not be worn in common areas such as break rooms, offices, or restrooms. Each department is responsible for providing laundry services as needed to maintain the hygiene of laboratory coats. They may not be cleaned by workers at private residences or public laundry facilities. Alternatives to laundering lab coats include routinely purchasing new lab coats for employees to replace contaminated lab coats, or using disposable lab coats.

Foot Protection

Closed-toe and closed-heel shoes must be worn at all times when in the laboratory; open-toe or open heel shoes, sandals, mules, clogs, etc. are not permitted in any circumstance. Each affected employee must wear protective footwear when working in areas where there is a high-risk of objects falling on or rolling across the foot, piercing the sole, and where the feet are exposed to electrical or chemical hazards. If there is a high risk of chemical contamination to the foot (e.g., cleaning up a chemical spill on the floor), then chemical-resistant booties may need to worn as well.

Minimum PPE Requirements for Support Staff and Visitors

Support staff (e.g., custodians, maintenance workers) and visitors often must enter laboratories to perform routine tasks such as maintenance or take a tour of the lab. These individuals are present in the laboratory, but are not performing work with or directly adjacent to any work with hazardous chemicals. To be present in the laboratory, the minimum PPE requirements include safety glasses, long pants, and closed-toe and closed-heel shoe. If additional PPE is required or if other unique safety requirements must be followed, it is the lab personnel's responsibility to notify support staff and/or visitors of the additional requirements.

PPE Training Requirements

Laboratory Supervisors must ensure that all employees receive PPE training before any work with hazardous materials occurs. This training must be documented. Each lab employee must be trained to know at least the following:

- When PPE is necessary;
- What PPE is necessary;
- How to properly don, doff, adjust, and wear PPE;
- The limitations of the PPE; and
- The proper care, maintenance, and useful life of PPE.

Each affected employee must demonstrate an understanding of the training provided, and the ability to use the PPE properly, before performing any work requiring the use of PPE. When the supervisor has reason to believe that an affected employee who has already been trained does not have the understanding and skill required (e.g., employee is seen handling hazardous materials without wearing proper PPE), then the supervisor must ensure the employee is retrained and notify the Chemical Hygiene Officer.

Injuries, Illnesses, and Medical Examinations

Employees must notify the Laboratory Supervisor, Division/Department Chair, or the Chemical Hygiene Officer concerning all injuries and illnesses regardless of how the magnitude. The laboratory supervisor must ensure that an injury report form is completed. Employees should report to a SCU approved occupational medical provider if medical attention is required (this information will be provided by AOPP). If the injury is serious and presents an emergency situation, dial 911 and emergency responders will respond and transport the patient to a local hospital emergency room.

Departments must provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory;

Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the permissible exposure limit) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard; and

Whenever an event takes place in the work area such as a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical examination. All medical examinations must be performed by or under the direct supervision of a licensed medical care provider and must be provided without cost to the employee.

8. HAZARDOUS WASTE MANAGEMENT

Introduction

Hazardous waste is generally defined as waste that is dangerous or potentially harmful to human health or the environment. Hazardous waste regulations are strictly enforced by both the Environmental Protection Agency (EPA), Department of Toxic Substance Control and the local Certified Unified Program Agency. The Laboratory Supervisor and the Chemical Hygiene Officer collectively are responsible for managing the hazardous waste program in a safe and compliant manner. No chemical waste should be poured down the drain or discarded in the trash unless it is certain that doing so does not violate hazardous waste regulations.

Hazardous wastes can be liquid, solid, gas, or sludge. They can be discarded chemicals or mixtures generated from research and teaching operations, commercial products (e.g., cleaning fluids or pesticides), or by-products of manufacturing processes. All hazardous waste falls into one of the following categories:

Characteristic Wastes: includes wastes that are ignitable, corrosive, reactive, or toxic (D-listed).

Listed Wastes: includes wastes from common manufacturing and industrial processes (F-listed), wastes from specific industries (K-listed), and wastes from commercial chemical products (U- and P-listed).

Universal Waste: includes certain batteries (primarily rechargeable batteries such lithium, nickel-cadmium, nickel metal hydride, and mercury oxide), mercury-containing equipment (e.g., thermometers, thermostats), and certain lamps (e.g., fluorescent bulbs). Note: alkaline batteries and incandescent bulbs are not considered Universal Wastes and can be legally disposed of as trash.

Mixed Waste: hazardous waste mixed with radioactive waste.

EPA-regulated hazardous waste should not be mistaken for biological or radiological wastes

8.1 WASTE IDENTIFICATION AND LABELING

All chemical constituents in a hazardous waste container must be identified by knowledgeable laboratory personnel. Not only is this required by the EPA, it also ensures that waste can be properly characterized and disposed of by AOPP. If there is uncertainty about the composition of a waste stream resulting from an experimental process, laboratory employees must consult the laboratory supervisor for assistance. In most cases, careful documentation and review of all chemical products used in the experimental protocol will result in accurate waste stream characterization. Additionally, review SDSs (specifically Section 2, “Hazard Identification” and Section 13, “Disposal Considerations”) to obtain information about hazardous constituents and characteristics.

All waste should be properly labeled as soon the first drop of waste enters a waste container. Containers must be labeled and clearly marked with words that describe the contents of the waste and the words "Hazardous Waste". Hazardous waste should be listed completely on the label provided by AOPP. If a chemical is found in the laboratory and the composition is unknown, it should be assumed to be hazardous and labeled as “Hazardous Waste – awaiting proper characterization.”

8.2 WASTE STORAGE REQUIREMENTS

Hazardous waste containers in SCU laboratories are stored in satellite accumulation areas (SAA) – inside the Anatomy Lab cold storage and inside the L-120 chemical storage room. SAAs are used to manage hazardous waste in laboratories and shops because doing so provides safe and effective means to accumulate hazardous waste before removal by AOPP. Additionally, SAAs provide the least restrictive regulatory option for the accumulation and storage of hazardous waste containers. AOPP reserves the right to issue citations for lab workers who improperly handle or label hazardous waste. The following SAA rules must be followed at all times when managing hazardous waste in a laboratory:

- All waste must be stored and in labeled containers;
- Containers must be in good condition and compatible with the waste they contain (no corrosive waste in metal containers);
- Containers must be kept closed at all times except when adding or removing waste;
- Containers must be labeled or clearly marked with words that describe the contents of the waste (e.g., liquid chromatography waste) and the words "Hazardous Waste";
- Containers must be stored at or near the point of generation and under the control of the generator of the waste (wastes should remain in the same room they were generated in). A central waste collection room should not be established;
- The waste storage volume should never exceed 55 gallons per SAA;
- Containers should be segregated by chemical compatibility during storage (e.g., acids away from bases, secondary containment can be used as a means of segregation); and
- Avoid halogenated and non-halogenated wastes in the same waste container.

Avoid mixing incompatible waste streams in the same container (e.g., acids with bases, oxidizers with organic solvents) that will potentially create an exothermic reaction in the waste container. If mixing waste streams does create heat, allow the container to vent and cool in a chemical fume hood before sealing to avoid over pressurization of the container.

Collect all highly toxic, reactive, mercury and any exotic wastes (e.g., dioxin compounds, PCBs, controlled substances) separately even if they are chemically compatible with other waste streams.

Failing to do so can result in costly disposal fees (e.g., mixing mercury with an organic solvent waste means that the entire waste stream must be treated as mercury waste).

8.3 WASTE CONTAINERS

AOPP does not provide containers to campus with the exception of formaldehyde waste containers. It is the responsibility of the generator of the waste to provide containers. Containers unsuitable for reuse will be properly disposed of and not returned.

SCU's policy for the disposal of empty containers is implemented to protect SCU facilities and the Physical Plant staff when removing trash. Please remember that some chemical residues have the potential to mix with other incompatible residues in the dumpster or compactor causing a reaction or fire. In addition, sealed containers may become pressurized during compaction, which may result in residues spraying onto workers. Please keep the following procedures and information in mind when disposing of empty containers:

- Triple rinse empty containers with a solvent capable of removing the original material.
- Identify triple-rinsed, dry, odorless, and empty containers by placing a "Safe for Disposal" on the container. Contact AOPP to request a supply of these labels.
- Remove any cap that may cause the container to become pressurized when compacting.
- Arrange removal of these containers with the Building Services staff in your area or take these containers to the designated area beside the dumpster outside your building.
- If unable to remove residual hazardous materials from containers, submit these to AOPP for pickup using the Hazardous Materials Pickup Request Form.

8.4 WASTE DISPOSAL PROCEDURES

AOPP provides pickup services for all chemical waste generated on campus. The following procedures must be followed in order to have hazardous waste removed from campus locations:

1. Prior to pick up, all waste must be placed in a designated area within the room where the waste was generated.
2. All waste must be placed in an appropriate container(s).
3. All containers must be capped and labeled.

8.5 UNKNOWN CHEMICAL WASTE

Unknown chemicals are a serious problem in laboratories. Mysterious chemicals are often stored in labs for years before lab personnel notice the unidentified items. However, steps can be taken to assist with proper management of unknowns. Unknown chemicals must be properly identified according to hazard class before proper disposal. The hazards that should be noted include: corrosive, flammable, oxidizer, reactive, toxic, and radioactive. The following subsections describe in detail how to properly manage unknown chemicals. If you are unable to determine what precise chemical is being handled, **DO NOT GUESS**. AOPP will arrange for a third party vendor to come and safety test and remove the chemical.

8.5.1 LABELING UNKNOWN CHEMICALS

Until the unknown chemical can be properly identified by either lab staff or AOPP, the container should be labeled with a Hazardous Waste Disposal Tag. The following information should be written on the label: “Unknown hazardous chemical, awaiting proper characterization by AOPP” as illustrated in Figure 8.7.

Figure 8.7 – Properly Labeled Unknown Waste

8.5.2 IDENTIFYING UNKNOWN CHEMICALS

Every effort should be made by laboratory personnel to identify unknown chemicals. Here are a few steps that can be taken to help this effort:

1. Ask other laboratory personnel if they are responsible for, or can help identify the unknown chemical; and
2. The type of research conducted in the laboratory can be useful information for making this determination. Eliminating certain chemicals as a possibility helps narrow the problem as well. This is especially important for mercury, PCB, or dioxin compounds because they must be managed separately from other hazardous waste.

8.5.3 REMOVING UNKNOWN CHEMICALS FROM THE WORK AREA

If it is not possible to identify the material, a "Hazardous Waste" label should be placed on the container as described above in Section 8.6.1

8.5.4 PREVENTING UNKNOWN CHEMICALS

Here are a few tips that will help prevent the generation of unknown chemicals:

- Label all chemical containers, including beakers, flasks, vials, and test tubes. The label should be placed on the container, not the cap to avoid accidental mislabeling;
- Immediately replace labels that have fallen off or that are deteriorated;

- Label containers using HMIS/GHS. Do not use abbreviations, structure, or formulae;
- Archived research samples are often stored in boxes containing hundreds of small vials.; Label the outside of the box with the chemical constituents paying special attention to regulated materials such as radioactive material, organic solvents, heavy metals and other toxics. If the samples are nonhazardous, label them as such;
- Request a Hazardous Materials Pickup to reduce the amount of chemicals in your laboratory; and
- Employees should dispose of all of their waste before leaving/graduating from SCU. The lab and/or department should come up with a system to ensure that all faculty, staff, and students properly dispose of hazardous waste, including unwanted research samples, before employees leave.

8.6 SINK AND TRASH DISPOSAL

No chemical waste should be poured down the drain or discarded in the trash unless it is certain that doing so does not violate hazardous waste regulations. In order to ensure improper disposal does not occur, please consult the relevant SDS or contact AOPP for further information regarding non-hazardous chemical waste disposal.

8.7 SHARPS WASTE

Sharps are items capable of puncturing, cutting, or abrading the skin such as glass or plastic pipettes, broken glass, test tubes, petri dishes, razor blades, needles, and syringes with needles. Sharps waste contaminated with hazardous chemicals must be placed into puncture resistant containers (e.g., sharps container, plastic or metal container with lid) and properly labeled. All chemically contaminated waste should be inventoried on and a request for a Hazardous Materials Pickup should be sent to AOPP for proper disposal.

Clean uncontaminated broken glassware and plastic sharps should be placed in a corrugated cardboard box or other strong disposable container. Do not exceed 20 pounds. When ready for disposal, the box should be taped shut and prominently labeled as “Sharp Objects/Glass – Discard” or similar wording. The “Safe for Disposal” should also be affixed to the outside of the container. Contact AOPP for specific non-hazardous waste disposal instructions.

8.8 LIQUID CHROMATOGRAPHY WASTE

Liquid chromatography (LC) is an analytical technique used to separate, identify, quantify, and purify individual components of a mixture. This technique is very common in biological and chemical research. Because organic solvents (e.g., methanol, acetonitrile) are commonly used in the process, most LC waste is regulated by the EPA as hazardous waste. Consequently, all containers collecting LC waste must remain closed while the LC unit is in operation. It is neither acceptable to place a waste line running from the LC unit into an open waste container nor is it acceptable to use foil or Parafilm® as a means of closure as shown in Figure 8.8.

Figure 8.8 – Improper LC Waste Collection Practices

One of the following practices must be employed in order to comply with hazardous waste regulations for LC waste collection systems:

1. Purchase an engineered container and/or cap designed for LC waste collection. Figure 8.9 shows several examples of acceptable solutions for proper LC waste collection that can be purchased.

Figure 8.9 – Proper LC Waste Collection Options for Purchase

2. An existing cap can be modified by the research lab for LC waste collection. To modify an existing cap, a hole can be drilled into a cap. The diameter of the hole should be similar to the diameter of the waste line; there should be a tight fit between the container opening and waste line. In addition, a hole should be drilled to accommodate any exhaust filter or air valve tube that may be required. It is recommended that either a 4-liter container or 5-gallon carboy be used for waste collection. The modified cap should be replaced with a regular, unmodified cap once the container is full and ready for AOPP pickup..

9. CHEMICAL SPILLS

Chemical spills in the laboratory can pose a significant risk to human health and the environment. All lab personnel must be trained on how to properly respond to chemical spills in order to minimize risk. In general, chemical spills can be placed into one of two categories: non-emergency chemical spills, or emergency chemical spills.

9.1 NON-EMERGENCY CHEMICAL SPILL PROCEDURES

Non-emergency chemical spills are generally defined as less than 1 liter, do not involve a highly toxic or reactive material, do not present a significant fire or environmental hazard, and are not in a public area such as a hallway. These spills can be cleaned up by properly trained lab personnel using conventional lab PPE (e.g., safety glasses/goggles, lab coat, gloves, closed-toe and closed-heel shoes) and the lab spill kits provided in each lab. In general, when a non-emergency spill occurs in the lab the area around the spill should be isolated, everyone in the lab should be made aware of the spill, and the spilled material should be absorbed and collected using either pads or some other absorbent material such as oil dry or kitty litter. Decontamination of the spill area should be conducted using an appropriate solvent (soap and water is often the most effective). Proper PPE should be worn at all times and only trained personnel should conduct the cleanup. **Additionally, review the SDS(s) (specifically Section 6, "Accidental Release Measures") to obtain chemical-specific cleanup information**.

9.2 EMERGENCY CHEMICAL SPILL PROCEDURES

Emergency chemical spills are generally defined as greater than 1 liter, involve a highly toxic or reactive compound, present an immediate fire or environmental hazard, or require additional PPE (e.g., respirator) and specialized training to properly cleanup. The following procedures should be followed in the event of an emergency chemical spill:

Cease all activities and immediately evacuate the affected area (make sure that all personnel in the area are aware of the spill and also evacuate).

If chemical exposure has occurred to the skin or eyes, the affected personnel should be taken to the nearest safety shower and eyewash station.

Dial 911, which will initiate both the local Police and Fire Department response, if the situation is, or could become an emergency (e.g., chemical exposure has occurred, a fire or explosion has occurred).

The fire alarm should be pulled, which will initiate building evacuation, if any of the following occurs:

- A fire and/or explosion has occurred (or there is a threat of fire and/or explosion);
- The large spill (which is either highly toxic or presents an immediate fire or environmental hazard) is in a public area such as a hallway;
- Toxic vapors are leaving the area where the spill has occurred, such as seeping from the laboratory into the hallway or neighboring rooms; or
- You are unsure of the hazards and feel that the spill could be harmful to building occupants.

Ensure that no one else is allowed to enter the area until the spill has been properly cleaned up by the local Fire Department.

9.3 CHEMICAL SPILL KITS

Each laboratory has a spill response kit available for use. Lab spill kits can either be purchased from a vendor or created by lab personnel, but each spill kit should be equipped to handle small spills of the most common hazards in the laboratory. Basic spill kits are provided by AOPP. If you are aware of materials inside the lab that would require more sophisticated equipment, contain the Lab Supervisor or the Division/Department Chair. The kit should be equipped with response and cleanup materials such as:

- Absorbent materials such as pads, booms, and oil dry or kitty litter, booms, or pillows;
- Neutralizing agents (e.g., Neutrasorb®) for acids and/or bases if high volume of acids and/or bases are stored in the laboratory;
- Containers such as drums, buckets, and/or bags to containerize spilled material and contaminate debris generated during the cleanup process;
- PPE such as gloves, safety glasses and/or goggles, lab coat or apron, chemical-resistant booties;
- Caution tape or some other means to warn people of the spill.

9.4 TRAINING

Effective training is crucial to a successful laboratory safety program. The Laboratory Supervisor must actively participate in the training process to ensure that all lab employees are effectively trained before any work with hazardous materials occurs. This chapter details the minimum training requirements for all SCU laboratories. It should be noted that depending on the type of instruction being conducted and associated hazards, there may be additional training requirements that are not detailed in this chapter.

10. CHP TRAINING

As discussed in Chapter 1 of the CHP, all laboratory employees (instructors, graduate students, lab technicians/managers, post-docs, visiting scientists, etc.) must receive documented CHP training before any work with hazardous materials occurs. The Laboratory Supervisor is responsible for providing CHP training. Initial CHP training should include the following:

- Review the lab-specific CHP in its entirety;
- Review lab-specific hazard assessments;
- Review lab-specific SOPs;
- Review any other lab-specific protocol or requirements;
- Annual CHP Refresher Requirements;

After receiving the initial documented CHP training, all lab employees must receive annual CHP refresher training as well. This annual refresher training can be a condensed version of the initial CHP training, but should include at least the following elements:

- Review of the lab-specific hazard assessments (review of PPE requirements);
- Review of the lab-specific SOPs;

- Review of any additional lab-specific rules and requirements;
- Review of chemical spill and lab emergency procedures.

10.1 PPE TRAINING

As discussed in Chapter 7of the CHP, the Laboratory Supervisor must ensure that all lab employees receive documented PPE training before any work with hazardous materials occurs. Document PPE training and ensure that each lab employee is trained to know at least the following:

1. When PPE is necessary;
2. What PPE is necessary;
3. How to properly don, doff, adjust, and wear PPE;
4. The limitations of the PPE; and
5. The proper care, maintenance, and useful life of PPE

Each affected employee must demonstrate an understanding of the training provided, and the ability to use the PPE properly, before performing any work requiring the use of PPE.

Training of all CSIH faculty and lab assistants shall occur at least once each calendar year and immediately upon the hiring of new faculty.

10.2 SOP TRAINING

As discussed in Chapter 4 of the CHP, SOPs are written instructions that detail the steps that will be performed during a given procedure and include information about potential hazards and how these hazards will be mitigated. SOPs must be developed for all high-hazard tasks that are performed in the lab, which is defined as work with:

- Explosives;
- Water-reactive, pyrophoric, self-heating, or self-reactive chemicals;
- Particularly hazardous substances, which includes carcinogens, reproductive toxins, and acutely toxic substances;
- Compressed gases;
- Work involving more than 1 liter of flammable liquids, flammable solids, corrosives, oxidizers, or organic peroxides at one time; and
- High-hazard tasks can also include work with equipment that creates particularly hazardous conditions. Examples include solvent distillation, work with high-pressure systems, hydrogenation, work with cryogenic chemicals such as liquid nitrogen, etc.

The Laboratory Supervisor must ensure that all applicable personnel receive documented training on lab-specific SOPs.

Appendix A

JOB DESCRIPTION AND EXPECTATIONS

JOB TITLE:	Chief Lab Technician
COLLEGE:	College of Science and Integrative Health
STATUS:	Exempt
REPORTS TO:	Dean of the college
JOB SUMMARY:	The lab technician is a full-time faculty member who reports to the Dean of the college and oversees the health professions laboratories including teaching, safety, compliance, waste management, and curriculum design.

JOB RESPONSIBILITIES

Reporting to the Dean, the Chief Lab Technician shall:

- Support the Mission, Vision, and Values of SCU.
- Ensure that the Department remains focused on educational excellence and student learning.
- Support the Dean.
- Improve integration across all appropriate SCU departments.
- Collaborate with Academic Division and Department Chairs in all matters of curriculum.
- Complete delegated tasks and responsibilities in a timely manner.
- Participate in appropriate university activities; serving on teams and committees, including the Dean's Council, as directed by the Dean.
- Supervise as requested.
- Proposal and implementation of department curricular improvement and development initiatives through appropriate governance structures.
- Active participation in quality assurance processes.
- Provide chemical safety and waste management and environmental compliance.
- Enforce industrial hygiene.
- Be the authority for elements of the fire safety program.
- Take responsibility for the University's compliance with a variety of Federal, state, and local regulations within the laboratories.
- Provide 24-hour availability as Incident Commander when responding to chemical spills.
- In addition to laboratory duties, the lab technician is a member of the faculty and as such is expected to engage in teaching, service, and scholarship.
- Other duties and responsibilities as assigned.

Supervisory Responsibilities

- Carry out employee supervisory responsibilities in accordance with SCU's policies and applicable laws. Generally, these responsibilities include participation in the interviewing, hiring, and training of laboratory employees. Further, this involves planning, assigning, and directing work; appraising performance; participating in the rewarding and disciplining employees; addressing complaints and resolving problems. Specifically:

- Supervise, evaluate and direct the laboratory assistants, delegating responsibility as appropriate and necessary.
- Supervise staff as it pertains to safety and compliance in the laboratories.
- Provide overall direction, coordination, and evaluation of laboratory instructors – including the Faculty Performance Appraisal process.
- Conduct regular one-on-one meetings with laboratory assistants and instructors.

Other Essential Job Functions

In addition to the job responsibilities described above, all employees of Southern California University of Health Sciences are responsible for the following essential job functions:

- Getting along with co-workers
- Cooperating with co-workers
- Responding politely to customers/students/candidates
- Working as a team member
- Being able to think quickly and act appropriately in emergency situations
- Functioning under intense time pressure
- Working extra hours as required
- Continuing to perform well under pressure

SCU Core Values:
1) Transparency
2) Grit
3) Sense of humor

SCU Permission-to-Play Values:
1) Respect
2) Integrity
3) Emotional intelligence
4) Team player
5) Accountability
6) Collegiality
7) Authenticity

SCU Aspirational Values:
1) Evidence based
2) Passion
3) Extra mile
4) Integrative
5) Adaptability

Common Profile Qualities:
1) Customer service focused
2) Willing to invest in student/client success by fostering positive relations, guidance, and assistance
3) A belief that no task that improves the University is beneath us/servant leadership
4) Be an ambassador of the brand
5) Be a part of recruitment
6) Resource innovator

Profile-Specific Qualities:
1) An understanding of SCU history
2) Excellent communication skills
3) Strategic community and external perspective
4) Support philanthropic endeavors
5) Connect, engage, and give (minimum alumni member and University Partner)
6) Self-reflection – reflective practitioner
7) Ability to utilize transformational leadership
8) Able to maintain confidentiality
9) Able to engage in constructive conflict
10) Models professional leadership
11) Be champions of the University mission, vision & values

12) Strategic oversight of their area and assigned initiative
13) Demonstrate commitment to promoting & enhancing diversity in all forms.
14) Seize initiative where required
15) Bring best ideas & perspectives to issues of importance for the good of SCU.
16) Individually and collectively prepared for substantive conversations.
17) Forge partnerships in conjunction with their supervisor
18) Civic engagement
19) Constructive support for each other & SCU
20) Innovation/Continuous Improvements/Assessments

21) Build and participate in campus community

22) Good organizational skills

Additional Qualities for Academic Leaders:

1) Exemplar scholars, teachers, and practitioners
2) Student advocate
3) Proficient in student assessment, academic program review, and regional and professional accreditation

JOB SPECIFICATIONS:

EDUCATION:	*Master's degree (M. A.) or equivalent (doctorate in related field preferred); or at least 5 years related experience and/or training; or equivalent combination of education and experience.
EXPERIENCE:	• At least five (5) years of successful teaching experience, or equivalent, in an accredited institute of higher education. • Track record of scholarly production.
TECHNICAL:	• Excellent PC skills in a Windows OS environment; proficiency with Microsoft Office applications including Word, Excel, PowerPoint.
ABILITIES:	• Strong organizational skills; detail oriented and accurate with ability to multi-task; excellent communication and customer service skills, and ability to think and act strategically.

Last updated: 07-14

Appendix B

Lab Checklist

Reminder: Report any injuries to Security immediately at EXT: 333 and notify the College of Science and Integrative Health

Today's Date: ___________________

Lab: ___________________________ Room Number: __________________

Please check the box after each item is completed. If not applicable for your lab, please write N/A.

- ☐ All chemicals are stored in the appropriate cabinets
- ☐ All secondary containers are appropriately labeled per the Chemical Hygiene Plan
- ☐ Tools/equipment are stored in cabinets
- ☐ All chemical cabinets are locked
- ☐ Counters have been wiped down with 70% ethanol
- ☐ Lab supplies/miscellaneous papers have been cleared off counters
- ☐ Specimens/ models are appropriately stored
- ☐ Scalpels and knives are cleaned and put in appropriate storage area
- ☐ Items for disposal are placed in the appropriate collection containers
- ☐ Gas valves are turned off
- ☐ Eye wash stations have been checked and are running properly
- ☐ Lab is left the way it was found
- ☐ All lights are turned off
- ☐ All classroom doors are closed and locked

Anything out of the ordinary that needs to be reported or addressed: ______________________________

____

____

Lab instructor's name: ________________________ Signature: ______________________________

Lab instructor's name: ________________________ Signature: ______________________________

Lab TA's name: ______________________________ Signature: ______________________________

Appendix C

Standard Operating Procedure

Click here to enter chemical name or class.

This is an SOP template and is not complete until: 1) lab specific information is entered into the box below 2) lab specific protocol/procedure is added to the protocol/procedure section and 3) SOP has been signed and dated by the Lab Supervisor and relevant lab personnel.

Print a copy and insert into your
Laboratory Safety Manual and *Chemical Hygiene Plan*.

Department:	Click here to enter text.
Date SOP was written:	Click here to enter a date.
Date SOP was approved by Lab Supervisor:	Click here to enter a date.
Lab Supervisor:	Click here to enter text.
Lab Safety Coordinator/Lab Instructor:	Click here to enter text.
Lab Phone:	Click here to enter text.
Office Phone:	Click here to enter text.
Emergency Contact:	Click here to enter text. *(Name and Phone Number)*
Location(s) covered by this SOP:	Click here to enter text. *(Building/Room Number)*

Type of SOP: ☐ Process ☐Hazardous Chemical

☐ Hazardous Class

Purpose

Click here to enter text.

Physical & Chemical Properties/Definition of Chemical Group

CAS#: Click here to enter text.

Class: Click here to enter text.

Molecular Formula: Click here to enter text.

Form (physical state): Click here to enter text.

Color: Click here to enter text.

Boiling point: Click here to enter text.

Potential Hazards/Toxicity

Click here to enter text.

Personal Protective Equipment (PPE)

Respirator Protection

Click here to enter text.

Respirators should be used only under any of the following circumstances:

- As a last line of defense (i.e., after engineering and administrative controls have been exhausted).
- When Permissible Exposure Limit (PEL) has exceeded or when there is a possibility that PEL will be exceeded.
- Regulations require the use of a respirator.
- An employer requires the use of a respirator.
- There is potential for harmful exposure due to an atmospheric contaminant (in the absence of PEL)
- As PPE in the event of a chemical spill clean-up process

Lab personnel intending to use/wear a respirator mask must be trained and fit-tested by EH&S. This is a regulatory requirement.

Hand Protection

Click here to enter text.

NOTE: Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with Click here to enter chemical name or class.

Refer to glove selection chart from the links below:
http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf
OR
http://www.allsafetyproducts.biz/page/74172
OR
http://www.showabestglove.com/site/default.aspx
OR
http://www.mapaglove.com/

Eye Protection

Click here to enter text.

Skin and Body Protection

Click here to enter text.

Hygiene Measures

Click here to enter text.

Engineering Controls

Click here to enter text.

First Aid Procedures

If inhaled

Click here to enter text.

In case of skin contact

Click here to enter text.

In case of eye contact
Click here to enter text.

If swallowed
Click here to enter text.

Special Handling and Storage Requirements

Click here to enter text.

Spill and Accident Procedure

Chemical Spill Dial 911

Spill – Assess the extent of danger. Help contaminated or injured persons. Evacuate the spill area. Avoid breathing vapors. If possible, confine the spill to a small area using a spill kit or absorbent material. Keep others from entering contaminated area (e.g., use caution tape, barriers, etc.).

Small (<1 L) – If you have training, you may assist in the clean-up effort. Use appropriate personal protective equipment and clean-up material for chemical spilled. Double bag spill waste in clear plastic bags, label and take to the next chemical waste pick-up.

Large (>1 L) – Dial **911**

Chemical Spill on Body or Clothes – Remove clothing and rinse body thoroughly in emergency shower for at least 15 minutes. Seek medical attention. *Notify supervisor immediately.*

Chemical Splash Into Eyes – Immediately rinse eyeball and inner surface of eyelid with water from the emergency eyewash station for 15 minutes by forcibly holding the eye open. Seek medical attention. *Notify supervisor immediately.*

- ## Medical Emergency Dial 911

Life Threatening Emergency, After Hours, Weekends And Holidays – Dial **911**. *Note: All serious injuries must be reported to EH&S within 8 hours.*

Needle stick/puncture exposure (as applicable to chemical handling procedure) – Wash the affected area with antiseptic soap and warm water for 15 minutes. For mucous membrane exposure, flush the affected area for 15 minutes using an eyewash station. Report to emergency. *Note: All needle stick/puncture exposures must be reported to EH&S within 8 hours.*

Decontamination/Waste Disposal Procedure

Click here to enter text.

General hazardous waste disposal guidelines:

Label Waste
- Affix a hazardous waste tag on all waste containers using the as soon as the first drop of waste is added to the container

Store Waste
- Store hazardous waste in closed containers, in secondary containment and in a designated location
- Double-bag dry waste using appropriate bags.
- Waste must be under the control of the person generating & disposing of it

Dispose of Waste
- Dispose of regularly generated chemical waste within 90 days

- Call EH&S for questions
- Empty Containers
    - Dispose as hazardous waste if it once held extremely hazardous waste (irrespective of the container size)
    - Consult waste pick-up schedule

Safety Data Sheet (SDS) Location

Online SDS can be accessed through SCU website.

Protocol/Procedure (Add lab specific Protocol/Procedure here)

Click here to enter text.

NOTE

Any deviation from this SOP requires approval from PI.

Documentation of Training (signature of all users is required)

- Prior to conducting any work with Click here to enter chemical name or class., designated personnel must provide training to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.

- The Principal Investigator must provide his/her laboratory personnel with a copy of this SOP and a copy of the SDS provided by the manufacturer.

- The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate laboratory safety training or refresher training within the last one year.

I have read and understand the content of this SOP:

Name	Signature	Date
Click here to enter text.		Click here to enter a date.
Click here to enter text.		Click here to enter a date.
Click here to enter text.		Click here to enter a date.
Click here to enter text.		Click here to enter a date.
Click here to enter text.		Click here to enter a date.
Click here to enter text.		Click here to enter a date.
Click here to enter text.		Click here to enter a date.
Click here to enter text.		Click here to enter a date.
Click here to enter text.		Click here to enter a date.
Click here to enter text.		Click here to enter a date.

Appendix D

CERTIFICATION OF HAZARD ASSESSMENT

Example

INTRODUCTION

"Hazard assessment" is the process (required by law) of identifying the hazards associated with defined task, prescribing personal protective equipment and other relevant protection measures which must be employed to reduce the risk from the hazards. "Certification of Hazard Assessment" is a written document -- such as the one on the following 2 pages -- detailing the hazard assessment(s) for (a) particular task(s). The supervisor is responsible for ensuring that hazard assessments are performed and the certification(s) written and posted. The supervisor may delegate or contract the labor involved in this process, but cannot reassign or disclaim the responsibility.

INSTRUCTIONS

- Save the attached hazard assessment example to your hard drive.
- **It must be modified to meet the specific hazards of your work area.** This includes removing or adding hazards as applicable to your work area.
- Certification(s) of hazard assessments **must be posted** -- tacked or hung in a visible place -- in every work room listed in the "location(s)" field.
- The fields at the beginning -- date(s), location(s), supervisor, and signature -- must be completed.

Post signed certification in work room.

Supervisor (print):	Assessment Date(s):
Signature:	Location(s) posted:

• **Hazards**	**Task:** hands-on work or being within reach[(a)] of potential hazards of described activity/items:	**Minimum Requirements**
Skin/eye damage, poisoning, inhalation of vapor or aerosol	Volume > 10 mL any unshielded[(b)] corrosive[(c)] liquids, organic liquids or liquid mixtures, or toxic[(d)] inorganic liquids/mixtures	Splash goggles, chemical resistant gloves[(e)], lab coat, skin cover to knees/elbows/throat, closed shoes with socks. Work in hood[(f)]. Shower and eyewash must be available in work area.
	Volume > 1 L	Same, but cover to ankles/wrists/throat
	Volume > 5 L	Add face shield covering chin
Cataracts, flash burns to cornea	Work with infrared emitting equipment (glass blowing)	Appropriate shaded goggles Lab coat, closed shoe, pants
Conjunctivitis, corneal damage, erythema	Arc/TIG welding	Appropriate shaded goggles Working gloves
Skin/limb injury	Machine operation activities likely to catch clothing, hair, or jewelry	Bind vulnerable clothing/hair, remove jewelry
Eye impact	Metalworking, woodworking, other operations likely to throw particles	Safety glasses No loose clothing or jewelry
Head impact	Working or walking in area having potential of falling tools, equipment, or stored items	Hard hat
Skin/eye damage	Cryogenic liquids	Splash goggles, skin cover to elbows/knees/throat, closed shoe easily removed, socks. Cryogloves for dispensing.
	Volume > 1 L	Skin cover to throat/wrists/ankles
Skin/eye damage, asphyxiation, body injury, frostbite,	Transport of liquid nitrogen in hallways and elevators	See cryogenic liquids; also all wheeled vessels or carts must restrain Dewar and have wheels large enough to safely traverse elevator door and scales gap.
	Self pressurizing vessels weighing > 100 lb gross	Plus skin cover to wrists/throat/ankles, always position blow-off valve away from body
	Dispensing from main bulk tank	All above and hearing protection
Frostbite, eye impact	Dry ice, very cold frozen solids.	Safety glasses, insulated gloves, skin cover to elbows/knees/throat, closed shoe w/ socks
Skin/eye damage	Hot liquid (rxn mixture, water bath, oil bath, autoclave, still...)	Splash goggles, insulated gloves, skin cover to knees/elbows/throat, closed shoe w/ socks
	Volume > 1 L	Skin cover to throat/wrists/ankles, emergency shower available in work area
Eye damage, Erythema	UV radiation	UV blocking goggles, skin cover on all potentially exposed areas
	Potential face UV exposure	UV face shield

Hazards	**Task:** (hands-on work or being within reach[a] of potential hazards of described activity/items	Minimum Requirements
Skin/eye damage	Laser radiation	Goggles appropriate to beam parameters, closed shoe, no jewelry/reflective items
	Class 3b and 4 lasers	Skin cover on all potentially exposed areas
Infectious disease	Human blood, cells, tissue, body fluids or materials derived from same	Safety glasses, "exam" gloves, skin cover on all potentially exposed areas, shoes/socks, work at Biosafety Level II.
	Liquid with vol > 1 mL	Same, but splash goggles, skin cover to throat/wrists/ankles
Skin/eye damage, poisoning, inhalation of airborne dust	Hazardous solids	Safety glasses, goggles for large quantities, chemical resistant gloves, skin cover to elbows/knees/throat, closed shoes/socks
	> 100 g any hazardous solid, or > 1 g "chemical requiring designated area," (list at REM web site[g]) or High potential for airborne particles	Same, except skin cover to wrists/ankles, and only work in hood
Cell damage, area contamination	Radioactive materials	Shielding and badging requirements prescribed in specific isotope SOP, use all appropriate chemical and/or biological safety personal protection

- **NOTES**

(a) Being within reach of potential hazards: "within reach" varies widely depending on scale and conditions of work and will be judged by affected staff in each room.
(b) Unshielded: not behind a drawn hood sash or blast shield.
(c) Corrosive: pH ≥ 12 or pH ≤ 2.5
(d) Toxic: having any poisonous or irritating effects to human tissue or human health.
(e) Chemical resistant gloves: glove thickness, length, and material must be chosen carefully and will be specific to the chemicals/mixtures used and the process conditions.
(f) Hood: 100% exhaust to outside, current approval for "all work" and functioning properly.
(g) Chemicals requiring designated areas: full list is at http://www.purdue.edu//rem/home/booklets/crdalist.pdf

Appendix E

Required PPE for laboratory courses:

*****First and foremost, all faculty/staff/students must wear long pants and closed-toe and closed-heeled shoes, and use *nitrile* gloves in all lab classrooms!! Prescription glasses, sunglasses, and the like do not qualify as safety glasses or goggles. The safety glasses or goggles listed below must be worn in laboratories where appropriate PPE is required. *****

1. **Anatomy & Physiology I & II**
   a. Encon Veratti 1410S or similar **safety glasses** (no goggles, no contact lenses)
   b. **White** (DC/MAOM/DAOM)or **disposable white** (IoS/ISP) lab coat (38" length)


2. **Biology/Chemistry/Biochem/OChem/Micro**
   a. **Indirect Vent chemical splash/impact goggles** (no safety glasses, no contact lenses)

   b. **Blue flame-resistant** lab coat
   (permanent or disposable – disposable may only be used for one term at most, cannot be washed, and must be disposed of if torn or compromised)

Appendix F

Lab Coat Information Table

Material	Vendor and Model Info	Splash Resistance/Chemical Resistance	Flame Resistance	Comfort	Uses/Comment
Polyester/Cotton Blend Listed by percent polyester then percent cotton. 80/20 or 65/35 or 40 /60 common. (Recommend at least 65%/35% for chemical research lab setting.)	Supplier: Cintas Manufacturer: Cintas Model: 59925 Supplier: North Star Manufacturer: Fashion Seal Model: 439	May be fluid resistant. Check information from manufacturer. Unknown chemical resistance. Anecdotally, better for work with acids than cotton.	No. Burns readily.	Lightweight breathable. The more cotton, the more breathable.	Most common for clinical settings (hospitals, clinical labs) and labs handling biological materials and small amounts of flammables. Limited testing indicates poly/cotton fabrics will burn readily upon contact with pyrophoric chemicals, so poly/cotton coats must not be worn for handling such chemicals.
100% Cotton	Supplier: Cintas Manufacturer: White Swan Model: 650 Supplier: North Star Manufacturer: Fashion Seal Model: 420	Not fluid resistant or fluid proof. Degraded by acids. Anecdotally, more resistant to solvents.	No. Burns less readily than poly/cotton blends, but still burns.	Lightweight breathable	
FR treated materials (either 100 % Cotton or primarily cotton treated with flame retardant)	Supplier: Cintas Manufacturer: Red Kap Model: KP72WH Supplier: North Star Manufacturer: Bulwark Model: KEL2LB	Not necessarily fluid resistant. Degraded by acids. More resistant to solvents. Not generally tested for chemical resistance.	Somewhat.	No information.	Better for lab settings with significant fire hazard, with an understanding of the limitations of the testing criteria for flame resistance (see background). Supplement with an apron for acid handling. More costly. Will not lose flame resistance with laundering over typical use life of coat. No bleach should be used by the laundry service.
Dupont Nomex	Supplier: Cintas Manufacturer: White Knight Model: OM60 Supplier: North Star Manufacturer: Bulwark Model: KNL6RB	Unknown splash and chemical resistance. There is a claim for chemical resistance, including acids, alkalis, and most solvents, but specific testing information could not be found.	Yes.	Breathable.	Expensive. Flame resistance is maintained even with laundering, provided bleach is not used. Good for settings where there may be an arc flash or flash fire. Used in petrochemical industry. Limited testing demonstrates nomex does not burn readily on contact with pyrophoric materials so is a good material for such work.

Polypropylene lab coat.	Various models available from VWR through ECAT. Ex: VWR Cat. #414004-346	No.	No.	Breathable	Intended for protection from dirt, grime, dry particulates in relatively non-hazardous environment such as animal handling and clean rooms. Burns readily.
VWR Microbreathe Lab Coat	Available from VWR through ECAT VWR cat. #14001-814	Fluid resistant for blood and body fluids and chemicals	No	Breathable	Disposable. For clinical and biological lab settings, and some chemical labs. Snap front, so can be readily removed. Not good for settings with significant fire hazard.
Kimberley Clark A65 Lab Coat (Disposable FR Coat)	Available from VWR through ECAT.	No Information.	Yes.	Breathable	Product literature mentions lab use.
Reusable Fluid Resistant Coats	Supplier: Cintas Manufacturer: White Knight Model: BAR 01 Supplier: North Star Manufacturer: Fashion Seal Model: 6403	Front material reportedly fluid resistant; "breathable" back material is not.	No	Permeable material in back of coat to increase comfort.	Generally the front and sleeves are "fluid resistant" material, while the back is a more permeable material for user comfort.