ENVIRONMENTAL HEALTH & SAFETY

UNIVERSITY of WASHINGTON

# UW LABORATORY SAFETY MANUAL

## DECEMBER 2024 EDITION

Environmental Health and Safety
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# FORWARD

The policies and procedures in this manual were developed by the University of Washington Environmental Health and Safety (EH&S) Department to provide information to protect personnel and the surrounding environment and to achieve compliance with applicable standards and regulations. This manual is developed in coordination with the University of Washington's Institutional Chemical and Physical Safety Committee (ICAPS) with the expectation that updates will be necessary as changes in regulations, policies and procedures dictate.

Implementation of these policies and procedures is the responsibility of the Responsible Party (RP) or Principal Investigator (PI) and depends largely on the efforts of laboratory supervisors and employees. It is essential that they seek additional advice and training when needed to conduct research in a manner that is safe for University personnel, students, and the surrounding community. To assist in this endeavor, the services of the Environmental Health and Safety Department are available at the University of Washington.

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# EMERGENCY INFORMATION

| | Telephone |
|---|---|
| Responsible Party (RP) /Supervisor: _____ | _____ |
| Building Coordinator: _____ | _____ |
| Department Safety Team Lead / Safety Coordinator: _____ | _____ |
| Custodial or Environmental Services: _____ | _____ |

## UW SEATTLE CONTACTS

| | |
|---|---|
| University of Washington (UW) Police (On Campus) | 911 |
| Seattle Fire Department (On Campus) | 911 |
| Employee Health Center | 206.685.1026 |
| Seattle Campus, South Lake Union | 206.897.1327 |
| Harborview | 206.744.3081 |

## ENVIRONMENTAL HEALTH AND SAFETY (EH&S)

| | |
|---|---|
| EH&S Main Office (Seattle) | 206.543.7262 |
| Research and Occupational Safety section (Seattle) | 206.221.7770 |
| Tacoma Campus, EH&S Manager | 253.692.4425 |
| Bothell Campus, EH&S Liaison | 425.352.3763 |

## AFTER HOURS, WEEKENDS AND HOLIDAYS

| | |
|---|---|
| UW Police (On Seattle Campus) | 911 |
| Seattle Fire (On Seattle Campus) | 911 |
| Environmental Health and Safety Staff-On-Call | Page through 206.685.UWPD |

## SITE-SPECIFIC EMERGENCY CONTACTS

_____

_____

_____

## Department's Supplemental Accident Prevention Plan can be accessed here:

_____

# LABORATORY-SPECIFIC INFORMATION

This Laboratory Safety Manual *serves* as the Chemical Hygiene Plan (CHP) belonging to:

**Laboratory Name:**

**Chemical Hygiene Officer (CHO)*:**

**Department:**

**Phone:**

* The Chemical Hygiene Officer (CHO) is the Responsible Party (RP), Faculty Member, or Supervisor who is responsible for the Chemical Hygiene Plan (CHP) in the unit or laboratory.

This CHP covers the following laboratory spaces:

| |
|---|
| Building(s): |
| Room #(s): |
| Shared Rooms and Common Areas (include building and room #): |
| |
| |
| |
| Names of PI(s)/Lab(s) that share the space(s): |
| |
| |

This CHP, consisting of the UW Laboratory Safety Manual and our laboratory-specific information, was reviewed and updated (required annually):

| | |
|---|---|
| On: | By: |

Items listed below identify the laboratory-specific information included in this file or stored in the following location:

Use checkmarks to indicate the item has been included, reviewed and updated as needed.

| Chemical Hygiene Plan Components | Check the box if included |
|---|---|
| Laboratory-specific information cover sheet (i.e., these pages) (required) | |
| Laboratory floor plan(s) (required) | |
| General laboratory safety rules, applicable throughout the laboratory | |
| Training records, including EH&S and lab-specific trainings (required) | |
| Standard Operating Procedures (SOPs) (required) | |
| MyChem Chemical Inventory (required) | |
| Safety Data Sheets (SDSs) (required) | |
| University or departmental safety rules that apply, equipment maintenance manuals, other documents (e.g., building evacuation plan or departmental health and safety plan) if filed separately from this CHP, etc., other reference materials | |
| Equipment maintenance and repair documentation/logs | |
| Designations of individuals performing particular tasks (e.g., checking first aid supplies, maintaining chemical inventories, etc.) | |
| Authorizations for individuals to use specific hazardous/controlled substances | |
| Any special instructions for receiving and storing hazardous materials | |
| Contents of first aid kit(s) and chemical spill kit(s) specific to work performed | |
| Any special instructions for labeling containers | |

Self-inspection records are stored in this file, on the laboratory survey dashboard, or another location (specify):

**Conducted on:** **By:**

Self-inspections are required at least once a year for the laboratory spaces covered by this CHP.

**Personnel list for the lab (include all staff and students):**

| Name | UW NetID | Title / Job Position |
|---|---|---|
| | | |
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# SECTION 1: LABORATORY RESPONSIBILITIES

***Contents***

## A. PURPOSE

The University of Washington (UW) has committed to create, maintain, and enhance a safe and healthful environment for all individuals associated with the institution, including students, faculty, staff, hospital patients, and visitors. This commitment is stated in UW **Presidential Executive Order 55**. A major part of demonstrating this commitment in chemical laboratories is documenting the safety program in the laboratory's chemical hygiene plan.

### 1. Chemical Hygiene Plan (CHP)

Washington Administrative Code (WAC) 296-828 requires that laboratories document their safety procedures in a Chemical Hygiene Plan (CHP). For UW chemical laboratories, the laboratory's chemical hygiene plan is created by combining laboratory-specific information and safety requirements found in the UW Laboratory Safety Manual (LSM).

Your lab's CHP can be electronic, paper, or a mix. It must be *accessible at all times* to all personnel who work in areas containing hazardous chemicals.

If the CHP is electronic, personnel must know where the files are located and how to access them. They must have access to the files on a computer that is retained in the space. For ease of electronic use, the UW Laboratory Safety Manual may be bookmarked in its entirety, or separate sections, templates, etc. can be bookmarked at www.ehs.washington.edu/resource/laboratory-safety-manual-510. When providing electronic information it must be obvious which files and documents are current. If an all-paper CHP is to be used, the lab- specific information can be filed in the front of the manual, behind the My Lab tab. The CHP must be accessible to all personnel, (i.e., it cannot be locked in an office). Laboratory- specific information such as chemical inventories, standard operating procedures (SOPs), safety data sheets (SDS) and other reference materials may be kept in the lab or elsewhere if necessary. Individuals may keep personal copies of the LSM and the lab's SOPs, but a master index of where the complete CHP is located, identifying the current revision number or date for each part, should be easily available at all times to personnel. Information not directly associated with safety procedures, which might be difficult to replace if lost, such as training certifications, may be kept separately in locked cabinets. Identify the location in the laboratory-specific information section.

### 2. Regulations Pertaining to the Chemical Hygiene Plan

This generic LSM contains information applicable to all University laboratories and explanatory materials to comply with regulations. Pertinent regulations covering laboratories include:

#### a. Hazardous Chemicals in Laboratories: WAC 296-828

State of Washington regulation (WAC) 296-828 , Hazardous Chemicals in Laboratories, is the primary Washington regulation covering laboratories performing chemical manipulations; it may also be referred to as the *Laboratory Safety Standard*. A copy of the WAC standard is provided as Appendix A of this manual. In chemical laboratories, this standard supersedes most of the chemical-safety requirements in other regulations.

#### b. Hazardous Drug Rule

Washington State promulgated WAC 296-62-500 , effective in 2014, which impacts the handling and disposal of drugs used for human treatment and veterinary care. The rule details the requirements for safe handling of chemotherapy and other hazardous drugs.

#### c. International Fire Code

US cities require compliance with the International Fire Code (IFC) and additional local requirements. For assistance with compliance, contact EH&S at 206.685.0341.

#### d. Chemical Waste Management

The UW LSM also includes information on chemical waste management in order to assist laboratories in complying with State of Washington regulatory standard WAC 173- 303, *Dangerous Waste Regulations*. Section 3 of the manual outlines the specifics of these requirements and describes safe disposal of hazardous chemicals.

#### e. US Department of Homeland Security Regulations

The United States Department of Homeland Security (DHS) developed the Chemical Facility Anti-Terrorism Standards (CFATS) to implement the federal regulations in 6 CFR Part 27. These standards required the University to track and control specific chemicals of interest. The federal CFATS act expired in July 28, 2023 and therefore there are no requirements for laboratories at this time. The University's MyChem chemical inventory system will continue to administratively track the chemicals of concern listed in the CFATS act..

### 3. Chemical Hygiene Plan Accessibility

The CHP must be accessible to personnel whenever the laboratory is occupied. If multiple rooms are included in the laboratory, the plan must be available withouthaving to get a key from another person or leaving the lab space. It must also be available on request to UW EH&S personnel and Washington State Department of Labor and Industries (L&I) representatives.

### 4. Other Plans and References

This CHP is a part of a complete safety program. Other University documents impacting laboratory operations may include the UW Radiation Safety Manual, Biosafety Manual, Laser Safety Manual, Field Operations Safety Manual or the Diving Safety Manual. External to the University, agencies providing grants may require additional plans and certifications to be part of the safety program.

### 5. Applicability to Students

It is the policy of the University that students in laboratories, while not legally covered under these procedures, are afforded the same level of protection as University employees. (Students who are not employees are not covered by Workers' Compensation in the event of an injury.)

## B. SCOPE AND APPLICATION

In general, the policies and procedures in the LSM apply at all locations that serve as assigned workplaces and educational settings for UW faculty, staff, and students. This includes the Seattle, Bothell, and Tacoma campuses, and other University-owned property, University-leased space, and temporary field locations that are under the control and supervision of UW personnel.

Any laboratory that meets the definition of a chemical laboratory (refer to B.1), must complete a CHP by adding laboratory-specific information to this manual. Laboratories that do not meet the definition of a chemical laboratory may refer to this manual for general safety information but must comply with industry regulations concerning chemical management.

### 1. Chemical Laboratory

A chemical laboratory is defined as an area (single room, a group of rooms, or a part of a room identified as a particular researcher's laboratory), where chemical manipulations are done for

research, educational, or clinical purposes. The manipulations must involve multiple hazardous chemicals or procedures involving hazardous chemicals done on a small scale (one person can easily handle the volume of the chemical in use). According to WAC 296-828 , a chemical laboratory must also utilize safety practices or safety equipment to reduce the risks of the hazardous chemicals. In addition, the chemical laboratory may not be a production-type facility where one process is performed repeatedly to produce a product for others.

### 2. Chemical and Non-Chemical Hazards

Hazardous chemicals are defined as those which either present or could cause a health hazard such as an acute skin burn from a corrosive acid or a disease from a chronic, long-term exposure, or a physical hazard from a chemical action such as a fire or explosion. Hazardous chemicals can often be identified from their labels, which could state "Danger," "Warning," "Caution" or words to that effect, or the label could have a symbol which indicates a hazard.

The chemical's SDS may also indicate that the chemical has hazardous properties, that the chemical could cause some disease or injury, or that personal protective equipment, such as gloves, is recommended when handling the chemical.

In addition to chemical hazards, this LSM provides information about general hazards (e.g., electrical safety, high noise, etc.) which may be present in the laboratory environment. Appendix B is a glossary of useful terminology applicable to this manual and related to both chemical and non-chemical hazards.

It would be impossible for one manual to provide complete information about all potential hazards and controls, so use of other references is encouraged. For example, refer to *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards (National Research Council Committee on Prudent Practices for Handling, Storage, and Disposal of Chemicals in Laboratories)*. This document is accessible with a UW NetID.

The EH&S website contains information about environmental, health and safety policies and procedures for all UW work areas, not just laboratories. Specific policies and procedures may be found in:

- Control of biological hazards in the UW Biosafety Manual:
- Research diving in the UW Scientific Diving Safety Manual:
- Laser safety in the UW Laser Safety Manual:
- Control of radioactive hazards in the UW Radiation Safety Manual
- Field research safety in the UW Field Operations Safety Manual

## C. RESPONSIBILITIES

Information about the appropriate actions to support safe laboratory environments, organized by level in the University organization, can be found in the UW Laboratories Safety Responsibility Matrix.

### 1. Responsible Party (RP) and Chemical Hygiene Officer (CHO)

Each chemical laboratory must have a single Responsible Party (RP), who is most often the Principal Investigator (PI) or Director. The RP is an individual who is designated the authority by a University department, school or administrative unit to direct the research or teaching program or

project. The RP has scientific and technical direction for the research or activities in the lab space. The RP has the responsibility and authority to enforce safety regulations and policies; this includes ensuring that the facilities are appropriate for the research conducted.

Based on State requirements, each chemical laboratory must also have a designated CHO who is knowledgeable about the laboratory's procedures, is actively involved or observant of those procedures performed, and has the authority to enforce correct procedures.

In research and teaching laboratories, the RP is the CHO by default. If the RP has other commitments that prevent knowledge of the laboratory's day-to-day activities, they may delegate that role to a person in their laboratory who is appropriately experienced and trained. This may be a laboratory supervisor, manager, or other senior-level person with authority familiar with activities within the laboratory. The CHO must be identified by name in the laboratory-specific section of the lab's CHP. If the RP assigns another person to be the laboratory's CHO, the RP is still the responsible party for the laboratory.
The CHO must ensure that laboratory-specific information is documented in the CHP and that activities conducted within the laboratory are consistent with the CHP. To aid in compiling laboratory-specific information, a template and guides for laboratory-specific information are available at the beginning and in Appendix C of this manual. This template also makes it easier to identify the CHO by name and to remember when the annual review of the CHP is due.

The laboratory's RP must ensure the following is accomplished:

**a. Develop the CHP**

A chemical laboratory must have a CHP. It consists of the UW Laboratory Safety Manual plus laboratory-specific information. Major areas of the laboratory-specific information portion include:

- The safety requirements, either as laboratory rules or standard operating procedures (SOPs), including PPE requirements;
- Laboratory-specific topics, including hazardous environments, materials and equipment used, covered in the laboratory's training program;
- Additional details specific to the laboratory and generally described on the laboratory-specific information at the beginning of the LSM.

**b. Create a List of Chemicals Stored in the Laboratory**

An accurate list of chemicals must be entered into the UW MyChem inventory management system and reviewed annually, at minimum. If they are not already online, upload SDSs to the MyChem Inventory when received in the laboratory. MyChem procedures are described in Section 2.B of the UW Laboratory Safety Manual. Additional information can be found on the EH&S website.

**c. Identify Hazards and Assess Risk**

The laboratory's RP must ensure all laboratory personnel understand that new and changed procedures must be assessed for hazards. The laboratory's RP, CHO, or another person familiar with the laboratory's procedures must assess those procedures and determine controls to adequately minimize risks. Any laboratory member can identify hazardous conditions that could result in personal injury or property damage. Once identified, the hazardous conditions and level of risk must be assessed.

Steps in the assessment include:

1. Research chemicals and processes to be used.
2. Identify and evaluate all types of hazards involved. Some evaluations to

consider*: what are the hazards? What is the worst that can happen? What can be done to prevent that? What can be done to minimize each risk? What should be done if something goes wrong?*

3. Consider if additional hazards may be present, if scaling up
4. Select controls to adequately lower the perceived risks, usingthe hierarchy of controls (starting with the most effective):
    - Eliminate hazardous substances and hazardous steps in the process (if possible),
    - Substitute with less-hazardous chemicals, smaller quantities, and safer processes Implement engineering controls, such as local ventilation or remote controls,
    - Implement administrative controls, such as an after-hours policy during exceptionally hazardous processes
    - As a last line of defense, assess PPE requirements
    - A Laboratory PPE Hazard Assessment Guide that can be used for additional guidance on general PPE practices is available on the EH&S website..
    - Additional information on hazard identification can be found in the document: *Identifying and Evaluating Hazards in Research Laboratories: Guidelines Developed by the Hazards Identification and Evaluation Task Force of the American Chemical Society's Committee on Chemical Safety, 2013*.
5. Ensure emergency response situations have been addressed:

Document hazards identified, assessment of risk, and safety measures for any new procedures, practices, or spaces involving usage of hazardous chemicals or materials. A risk assessment tool and guide are available on the EH&S website. If the assessment results in requirements for controls, those requirements must be documented in lab protocols (as described in the following paragraph).

**d. Document and Enforce Appropriate Safety Practices**

Safe work practices and rules required within the laboratory must be documented. Requirements can be documented as "general lab rules" (Section 2 of this manual) conspicuously posted in the laboratory or included in lab protocols or SOPs (Section 6). If an individual fails to follow the requirements, the laboratory's RP must initiate enforcement actions and document those actions.

Document lab hazard assessments and risk mitigation strategies in place for new or routine work.

Update documents when any changes are made to the work, including change of location.

**e. Ensure Signage/Labels in Place**

Appropriate signage must be posted, and hazardous material containers (including hazardous waste containers) must be labeled. Laboratory signage is described in Sections 2.A.6 and 4.C; labeling is described in Section 2.E of this manual.

**f. Assess, Provide and Document Training**

The laboratory's RP must ensure that training requirements for personnel are determined depending on their duties. Employees, volunteers, visiting scientists, and students working in the

laboratory must receive general and laboratory-specific training, including the hazards of the chemicals present, and the required safety procedures including proper use of PPE. The department (or others) may provide information about the UW's general requirements such as the UW Accident Prevention Plan and emergency response procedures. Laboratory personnel are responsible for training requirements concerning the materials and the processes conducted within the laboratory; the assessment and training must be documented.

Details are available in Section 7 of this manual. A matrix that provides information about mandatory and recommended classes is available on the EH&S website.

**g. Ensure Personnel Have Access to Safety Information**

All personnel who work in areas with hazardous chemicals must have access to essential safety information while they are at work, including the CHP, SDSs and the regulation WAC 296-828, *Hazardous Chemicals in Laboratories*. Make this information available in the laboratory space where work is performed.

(Note: The CHP includes the UW LSM and laboratory-specific information such as SOPs and the chemical inventory. The regulation is Appendix A of the UW LSM.)

**h. Ensure Visitor Safety**

1. Before starting any chemical use, visiting scientists and volunteers performing procedures within the laboratory must receive equivalent training as other employees on the hazards and safety precautions, including requirements for use of PPE.

2. Visitors, such as emergency responders, facilities personnel and contractors, must be protected from the hazards within the laboratory (e.g., surfaces and equipment must be decontaminated and cleaned prior to allowing visitors to contact such surfaces and equipment.) Information about preparing work areas and equipment for servicing by maintenance personnel is in Section 4.G of this manual and in the Notice of Cleaning and Decontamination Form; information about decontaminating equipment and facilities for disposal or lab relocation is in Section 4.H.

**i. Enforce Restrictions on Children and Minors**

In accordance with University of Washington Administrative Policy Statement 10.9, the laboratory must not be used as a childcare area.

Minors (ages 14-17) working in the laboratory as volunteer workers or as employees must not be exposed to agents that pose higher health risks as described in WAC 296-125-030 and the U.S. Department of Labor Child Labor Provisions. These risks include such materials as human body fluids, radioactive and hazardous substances, or jobs requiring PPE other than gloves, boots, eye protection or hard hats.

There are specific student-learner exemptions that apply to minors (ages 16 and 17) if the work or volunteer appointment is part of a vocational education program, or if the minor is enrolled in a UW academic course for credit. For questions about the regulatory exemption, contact EH&S at 206.543.7262 or the UW Office of the Youth Protection Coordinator.

**j. Enforce Restrictions on Pets**

WAC 478-128 prohibits pets in all University facilities. Personnel are prohibited from bringing pets into any University facility, including laboratories. Refer to UW policies regarding service animals for more information.

UW Administrative Policy Statement 46.6 affords individuals with disabilities who require the assistance of a service animal equal opportunity to access University property, courses, programs, and activities.
A service animal may be restricted from specific areas of the University when consistent with other University policies, state, and/or federal laws/regulations. Examples of these areas may include:

- Food preparation areas
- Animal research facilities and grounds
- Medically sensitive patient and clinic areas
- Biologically sensitive or hazardous research sites

If a service animal is restricted from certain areas, the designated disability services offices are available to assist in evaluating reasonable accommodations for the owner. If service animals are **NOT** restricted from a laboratory area, then the RP for that area should manage all safety needs for the animal, including any needed PPE.

**k. Perform Annual Reviews and Update Documents**

Annually, someone in the laboratory must check that revised information has been integrated into the CHP and review that conditions have not altered from a safety perspective by doing the following:

- Check (December, annually) for revisions to the LSM; obtain a current copy of the LSM and make it available to all personnel.
- Check that actual laboratory procedures and conditions remain consistent with SOPs and other laboratory-specific information.
- Verify your lab's MyChem chemical inventory is current; ensure that a collection of outdated or legacy chemicals does not occur in inventory and SDSs.
- Review internal inspection results, routine maintenance records, and the condition of equipment used by laboratory personnel to identify possible safety deficiencies, such as dirty, defective, or worn equipment, out-of-date fire extinguisher, out-of-date emergency shower inspections, etc.
- It is recommended that laboratory personnel make any changes necessary and note the annual review date of the CHP ; maintain documentation in the laboratory-specific information section of the CHP. If there are major changes during the year, it is recommended that laboratory personnel update the laboratory-specific information as conditions or procedures change.

**l. Perform Accident Follow-up**

All accidents and incidents must be investigated. Any accidents/incidents resulting in injury to personnel to the extent that they need medical attention and accidents/incidents involving unplanned fires and explosions must be reported to the laboratory's RP and to EH&S. It is recommended that incidents that do not result in significant injury or damage, but do result in near misses, also be reported to the laboratory's RP and to EH&S.
Details for accident follow-up are provided in Section 9.B of this manual, including reporting requirements. If it is recognized that an SOP could be improved to mitigate risk, it must be updated prior to performing the procedure again.

**m. Perform Lab Safety Inspections and Assist EH&S Inspections**

It is expected that laboratory personnel perform formal self-inspections using a checklist or other form of documentation at least annually. The inspection checklist used by the EH&S laboratory

safety team can be augmented with additional items regarding laboratory-specific conditions. It can also be completed and stored on the lab safety dashboard. Self-inspections should be independent of any other inspections— i.e., they should not be just preparation or response for third-party audits or inspections.

If safety deficiencies are identified, they must be addressed as soon as possible. Documentation of the inspections and follow-up should be maintained for three years. It is recommended that all inspections have some type of documentation, and that different people perform them to share knowledge and gather different viewpoints.

The frequency of self-inspections may vary depending on the number of safety challenges identified, and the schedule may be changed on an annual basis (especially if laboratory personnel and procedures remain constant and few new pieces of equipment are obtained). A minimum of one self-inspection should be performed annually. Additional guidance and tools for self-inspections can be found on the EH&S website.

When contacted by EH&S to schedule an inspection, the RP is expected to be responsive in scheduling and providing laboratory-specific information as requested. Inspection findings should be addressed and corrected in the time specified (typically 30 calendar days). All laboratory personnel are expected to support the inspection as requested.

## 2. Dean, Department Chair and Director

The Dean, Department Chair and Director are responsible for the following:

### a. Ensure Safety of Laboratory Occupants

"Provide a safe and healthy workplace free from recognized hazards" (WAC 296-800-110). This can be accomplished by:

- Being aware of the University's Accident Prevention Program (APP).
- Using the Supplemental Accident Prevention Plan (SAPP) template to organize worksite-specific health and safety information for a Department health and safety plan, and address employee protections from site-specific occupational hazards that extend beyond the University of Washington Accident Prevention Plan.
- Ensuring personnel are oriented to the APP and SAPP.
- Being aware of the general requirements in this manual and other safety and health requirements and taking a reasonable approach in minimizing hazards and risks.
- Ensuring lab space assigned is suitable for the intended work and has been cleaned and/or decontaminated as appropriate if the space supported previous research activities. If ventilation is needed, ensure a fume hood (or equivalent) is present and in working order. If hazardous chemicals are in use, ensure emergency washing (eyewash and shower) is available.
- Ensuring new lab builds or remodels are designed following the Laboratory Safety Design Guide.
- Enforcing corridor policy as it pertains to lab work, equipment, and supplies.
- Ensuring routine inspections of emergency washing equipment, fire extinguishers, and autoclaves are performed for all labs.
- Orienting new RPs, visiting scientists, and postdoctoral researchers to required lab safety training and safety resources.
- Providing information on required authorizations as needed.

- Ensuring lab moves are following clean out and decontamination procedures and ensure all
- surplus of laboratory items follow established surplus guidelines

#### b. Ensure Visitor Safety

The department should conduct a risk assessment and develop a plan to accommodate visitors safely for events such as field trips or lab tours. Conduct a visitor orientation on the potential hazards and safety measures including PPE requirements for the visit. Additional topics covered may include items allowed to be handled, safety and emergency equipment available, and emergency and evacuation practices.
Additional considerations apply for youth in labs which can be found on the Office of the Youth Protection Coordinator website.

#### c. Enforce Laboratory Control Methods

Ensure SOPs concerning use of particularly hazardous substances identify authorization requirements and maintain records of training completion. (For more information, SOP development is described in Section 6 and recommended controls are provided in Section 2.G).

Ensure that safety records are maintained as described in Section 7: Safety Training and in Section 8: Record Keeping.

#### d. Review Accidents

Have procedures in place to become aware of accidents affecting laboratory operations within your department, and ensure corrective actions are taken, if necessary, to prevent accident recurrence.

#### e. Review and Follow Up on Inspection Findings

Ensure that corrective actions are completed for safety inspections. Provide a response within 15 business days indicating when any outstanding inspection findings were addressed. EH&S recognizes that some findings may require longer than the response window to correct; in these cases, a response indicating the plan for making corrections is requested.

#### f. Ensure Appropriate Laboratory Closures/Moves

Ensure laboratory closures or moves are done responsibly (Section 10).

#### g. Assume RP duties or assure a RP is appointed for a laboratory when there is an extended absence of the PI or RP.

This may be due to a RP's sabbatical, extended remote work assignment, retirement, or illness.

#### h. Obtain Hazardous Material Permits

Hazardous Material Permits must be obtained from your local fire department (Bothell, Seattle, Tacoma, or other). Departments or building management may obtain permits covering all their laboratories. If they do not, the laboratory's RP must ensure the permit is acquired. This is most frequently a concern when a laboratory relocates, or a new research project involves highly hazardous chemicals. Contact your Departmental Safety Officer, Departmental Administrator, or EH&S at 206.685.0341 for advice. Permits must be readily available upon request by the fire code authority. EH&S may also need to review these permits to ensure permit conditions are met.

### 3. Employees/Students

Employees and students have a responsibility to:

#### a. Comply with Guidelines and Policies

Know and comply with lab safety guidelines and policies required for all assigned tasks.

#### b. Report Unsafe Conditions

Report unsafe conditions to your laboratory's CHO, PI, a faculty member, your immediate supervisor, the Departmental Safety Officer, or EH&S (206.543.7262). If you identify a procedure or assigned task as being exceptionally risky, you can perform it only after you believe the risk has been reduced to an acceptable level.

#### c. Report Accidents

Report accidents and incidents to your supervisor, and to the University using the online accident reporting system (OARS).

#### d. Use Personal Protective Equipment

Select, maintain and use PPE based on the requirements and exposure assessment and consistent with your training. Students may be required to provide their own PPE for use in academic laboratories and classrooms. Required PPE must be provided at no cost to personnel, including student employees.

### 4. Environmental Health & Safety Department

EH&S is responsible for the following:

#### a. Develop the Laboratory Safety Manual (and other Safety manuals, such as the Biosafety Manual and the Laser Safety Manual)

Produce and update the University Laboratory Safety Manual, which provides general information for each laboratory's Chemical Hygiene Plan; make the manual available through the EH&S website; announce updates on the EH&S website, in the EH&S newsletters, and by email, using MyChem contacts with active inventories.

#### b. Liaise with Regulatory Agencies

Act as the liaison between the University and the regulatory agencies enforcing environmental, health and safety regulations.

#### c. Advise Concerning Laboratory Safety

Assist laboratories (as needed) with the development of the laboratory-specific information required to complete their Chemical Hygiene Plan. Act as a resource regarding laboratory safety issues.

#### d. Perform Laboratory Inspections/Certifications/Equipment tests

Conduct regular laboratory inspections and assist in implementation of self-inspection procedures. Also conduct visits, inspections, surveys, and audits as appropriate for the lab support tasked to EH&S. Test or certify laboratory equipment (such as fume hoods, laminar flow hoods, and biosafety cabinets) on the schedules described in relevant EH&S SOPs.

#### e. Maintain a Safety Data Sheet (SDS) Database

Maintain an online SDS database that is available to the campus community. The MyChem database system also contains department-maintained chemical inventories, responsible parties and contacts, caution signs for visitors and emergency personnel, and a list of surplus chemicals.

#### f. Conduct General Lab Safety Training

Develop and provide general safety training courses in UW laboratory safety practices.

### 5. UW Chemical Hygiene Officer (CHO)

The Director of EH&S will appoint a University CHO to assist the laboratory CHOs to interpret the policies and requirements in the LSM as needed and to recommend changes in policies and programs as needed. This individual can be contacted by emailing ehsdept@uw.edu or by telephone to 206.543.7262.

### 6. Institutional Chemical and Physical Safety Committee (ICAPS)

The Institutional Chemical and Physical Safety (ICAPS) Committee is one of several University-wide committees charged with promoting a safe working environment at the UW. The committee has specific oversight responsibilities for chemical and physical safety in all research and teaching activities conducted in University owned and operated laboratories, as well as in field research.

The committee has the authority to recommend modification, suspension, revocation and/or termination of any activities that are deemed to pose an unacceptable risk to life or safety. Recommendations will be made to the EH&S Senior Director, department leadership, and University leadership as needed.

Safety concerns and issues identified by EH&S may be escalated to the committee for resolution.

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# SECTION 2 - CHEMICAL MANAGEMENT

***Contents***

# A. BASIC LABORATORY SAFETY PRACTICES

## 1. Working Alone

Working alone is when an individual is working unaccompanied, such that assistance is not readily available should an injury, illness, or emergency arise. Alone is interpreted as being out of direct visual contact or hearing range with other lab personnel for more than a few minutes. It can occur during normal working hours as well as during evening, night, or weekend hours and even in the same general area as others.

RPs should assess whether certain types of work and procedures conducted in the laboratory are appropriate to be done alone and inform all personnel of policies.

Follow the lab-specific policies around working alone. Do *not* work alone in the laboratory if the procedures conducted involve highly hazardous substances or processes (such as those described in section 2.G). If you are working alone with less hazardous chemicals, let personnel in other laboratories know of your presence or develop an accountability system with your supervisor or co- workers.

Review additional guidance on working alone safely.

## 2. Prevent Chemical Exposure

To avoid skin contact with or absorption of a chemical:

- Use appropriate PPE per the LSM, Section 5.B: (e.g., goggles, gloves, and/or lab coat) but consider it as the last line of defense.
- Use appropriate containment equipment and checking regularly that connections are tight.
- Clean up spills as soon as possible and minimize clutter at workspaces to avoid inadvertent exposure.
- Avoid practices that invite chemical contamination of the laboratory work surfaces and result in skin contact with chemicals, such as taping pipets to bottles of hazardous solutions for dedicated dispensing.

To avoid inhalation of a chemical:

- Use a fume hood whenever handling volatile or aerosolized chemicals, even if they are of relatively low toxicity.
- Cap chemicals as soon as possible. Vented caps are not permitted for chemical storage.
- Limit the smelling of chemicals as much as possible.
- Investigate the source of unfamiliar odors and eliminate them.

To avoid ingestion of a chemical:

- Do not taste any chemicals.
- Mouth suction must never be used to pipet chemicals or start a siphon; instead, use a pipet bulb or an aspirator.
- Avoid touching your mouth and face with your hands while working with chemicals.

To avoid injection of a chemical:

- Reduce or eliminate use of needles as much as possible.
- Dispose of needles as soon as any injection is complete.
- Use needles with inherent safety devices that prevent inadvertent needle sticks.
- Dispose of sharps into appropriate waste containers. Avoid storing sharps containers where they may get easily knocked over, and do not overfill sharps containers.
- If operating a high-pressure system, never check for a pressure leak using your hands.
- Do not carry any kind of laboratory sharp in your clothing or lab coat pocket.

### 3. Washing Hands

Wash hands well with soap and warm water after removing gloves and before leaving the laboratory area. Never wash with organic solvents. (Refer to section 5.B Personal Protective Equipment for more information.)

### 4. Food and Drink

Food and drink consumption in the laboratory increases the chance of exposure to chemicals; any consumables, including food and drink, are prohibited from being stored, prepared, or consumed in University laboratories.

#### a. Glassware/Utensils

Glassware or utensils used for laboratory operations must never be used to prepare or consume food or beverages.

#### b. Storage of Food/Beverages

Laboratory refrigerators, ice chests and cold rooms are not allowed for food or beverage storage intended for human consumption.

### 5. Access to Emergency Exits and Equipment

Emergency equipment, such as eyewashes, safety showers, fire extinguishers and fire alarm pull stations must be directly accessible. Eyewashes and showers are considered obstructed if they cannot be accessed without moving something, including temporary items, lab supplies, and equipment, or if something adjacent to the unit would make it unsafe to use. Ensure that no items are stored within a minimum 16-inch radius from the center of emergency showers. Eyewashes and showers are also considered obstructed if they have to be accessed by going through more than one door or a door that is locked. Storage, even temporary storage, and equipment must not block doorways, corridors, aisles, and stairways to assure unobstructed access to exits at all times, including in the event of an emergency.

### 6. Laboratory Signs

Laboratory Caution Signs must be posted (as described in Section 4.C). These signs provide laboratory specific information: emergency contact names and numbers, chemical, physical, and biological hazards, and entry requirements for visitors. Laboratories are required to post an up-to-date sign at the entrance to all rooms, except offices. The sign is intended to alert emergency responders and visitors of

potential hazards and precautions for entry.

Additional signage may be posted to alert to specific hazards (such as a laser, magnetic fields, or high voltage equipment), prohibit unsafe behavior, describe additional required protective measures or designate locations of various supplies and equipment.

Magnetic or framed signs may be used to designate a temporary hazard. Warning signs must be removed when the hazard no longer exists (such as a sign indicating the presence of a chemical that is no longer
kept in a laboratory).

Biohazard warning signs must be posted when BSL-2, BSL-2+, or BSL-3 work is performed. For BSL-2 laboratories, the Biohazard Warning Sign must be affixed to entry doors in a way such that it can be easily removed or turned over in circumstances when work is complete and support personnel or persons not conducting BSL-2 work may access the room.

## 7. Housekeeping

Laboratory bench tops and other work surfaces must provide enough space to safely execute procedures. Aisles and egress routes must be clear to allow for prompt evacuation in the event of a spill, fire, or other emergency.

Maintain the following housekeeping expectations in the laboratory at all times:

4. Keep flammable materials away from ignition sources.
5. Separate incompatible materials and chemicals.
6. Ensure emergency equipment and supplies (eyewash, shower, spill kit, first aid kit, fire extinguisher) are readily accessible.
7. Keep fume hoods uncluttered and unblocked by furniture or other objects.
8. Store chemicals in an orderly and upright manner; no crowding, precarious balancing, stacking, or open or damaged containers.
9. Complete chemical labels and make sure they are legible and visible when stored.
10. Avoid trips and falls by limiting floor storage.
11. Clean work surfaces, including replacing soiled pads or linings on the surface.
12. Keep sinks clear.
13. Minimize amounts of garbage/trash; no overflowing containers.
14. Protect tubing and power cords from physical damage and ensure they are not a tripping hazard.
15. Maintain defrosted freezers so that labels can be read, the condition of the containers can be assessed, and no containers are stuck in ice
16. Minimize associated risk of physical hazards (for example, large glass pieces) by appropriately sorting equipment with physical hazards.
17. Clear access to chemical storage areas.
18. Do not use broken containers or broken glassware.

## 8. Sharps Safety

Sharps are items used to cut or puncture skin or body parts, including needles, scalpels and lancets. Other sharps items can still cause injuries although they do not fit the regulatory definition of sharps, such as broken glass, glass septum vials, glass pipets, razor blades and sharp teeth and nails of research animals. Safety precautions are

necessary to prevent injury and exposure.

Identify sharps devices to be used in laboratory procedures. When possible, substitute a non-sharp alternative such as a blunt needle or plastic pipet, or consider using a safe sharps device. If a sharp must be used, training and practice are essential to prevent injury. Avoid recapping needles; if a needle must be recapped, use a needle holder to do so. Never leave an uncapped needle exposed in the work area. Promptly place all sharps waste into a red sharps container. Store reusable sharps in a labeled storage container such as a bucket or tray. Use a magnet to contain reusable metal sharps like razor blades.

Avoid factors and conditions that can lead to a sharps injury, such as rushing or working when you are tired or not feeling well. Keep work area organized and uncrowded so that sharp items are always visible. More information on sharps safety is available on the EH&S website.

## B. CHEMICAL INVENTORY AND THE SAFETY DATA SHEET (SDS)

Laboratories must maintain chemical inventories in MyChem, the UW's campus-wide chemical tracking system. MyChem is designed to track inventories during emergencies and assist laboratories in complying with federal, state and local regulations. Chemical inventories, location contacts and chemical-specific hazard summaries must be available to emergency personnel, so they know what chemicals may be involved in an accident and whom to contact in the event of an emergency. Laboratories should use MyChem inventories to keep track of chemicals, avoid unnecessary purchases, prevent keeping legacy or unneeded chemicals and submit chemical collection requests. Chemicals that are jointly purchased or for shared use should be listed in only one chemical inventory, requiring an RP to be determined by the purchasers.

Laboratory personnel are required to maintain up-to-date chemical inventories in MyChem and to review them annually in order to facilitate compliance with local Fire Department Hazardous Material Storage and Use Permits (occupancy permits), EPA Community Right-To-Know reporting and Department of Homeland Security chemical security requirements. Contact information in MyChem should also be kept up-to-date; delete contact information for anyone who no longer needs access to the chemical inventory.

MyChem stores approximately 500,000 hazard summaries in the form of SDSs. As the inventory is entered, the SDS is attached and readily accessible. All employees should be able to readily access an SDS for any chemical they are using.

All chemicals purchased for laboratory use are required to be entered into the MyChem inventory.

### 1. Access to MyChem

MyChem is the UW's centralized SDS database for chemicals used by University personnel. EH&S maintains the MyChem SDS database. Access to this database is appropriate for UW personnel who manage the chemicals in the laboratory. For access to SDSs log in to MyChem using your UW NetID email and password. For access to site-specific chemical inventories and the UW Chemical Exchange, click the 'Person' link in the top menu bar, fill out the form, and ask the PI or inventory manager to add you as a contact.

If you have questions or desire additional information, contact MyChem support at mychem@uw.edu or 206.616.4046.

## 2. Conducting Your Chemical Inventory

Personnel must inventory all chemicals found in the laboratory and specify the maximum amount normally found at this location. When adding chemicals to a MyChem inventory, make sure to search for and select the product with the same supplier and catalog number as the actual product in your lab. If, after reviewing the search results, there is not an exact match in the system, you must add a custom chemical to the system using the 'Chemical Not Found' button. This is the best way to ensure the proper SDS is available for emergencies and that the chemicals hazards are accurately represented.

Dilutions and reagents prepared in the lab for further work do not need to be included in the inventory, but must have a container label visible, unless the entire preparation is used or disposed of on the same day.

While conducting your physical inventory, examine containers for deterioration and integrity. Chemicals that are expired, corroded, or no longer needed should be managed as hazardous chemical waste. For more information about chemical waste management, refer to Section 3.

Update inventories when moving into a laboratory, starting a new project or when there are changes in your chemical inventory. Enter new chemicals into MyChem when they are received.

All inventories must be reviewed and verified for accuracy at least annually, including for rooms listed in your MyChem inventory that have no chemicals.

## 3. Safety Data Sheet (SDS)

SDSs are documents that describe the physical and health hazards of chemicals. Manufacturers of chemicals must provide SDSs for chemicals they sell. Information on SDSs can be found on the EH&S website.

Laboratory personnel must have access to SDSs for all chemicals used in the laboratory. The department or laboratory may choose whether to maintain the SDSs in electronic or paper format.

EH&S recommends laboratories maintain paper copies of or easily be able to print SDSs for the hazardous chemicals likely to spill and/or cause injury. Having an SDS immediately available when someone is exposed to a hazardous chemical aids emergency personnel in how to respond and treat that person.

Call EH&S at 206.616.4046 to request assistance locating or accessing SDSs during business hours. If the SDS is online in the MyChem system, EH&S will email a copy within one business day. Chemicals that do not have an SDS in the system will take longer to research and obtain. After business hours, contact the UWPD at 206.685.8973 and UWPD will contact an EH&S representative.

If an SDS is received with a chemical shipment, please scan and upload it for addition to your inventory in the MyChem database.

If synthesizing a hazardous chemical, the RP, CHO or manager must generate a Globally Harmonized System (GHS) compliant label and SDS before shipping or transporting the chemical away from the campus. Use the available template to make a GHS compliant SDS. Remember to add these chemicals to MyChem and upload your SDS.

All chemicals listed in your MyChem inventory must have an SDS listed for them in the MyChem database. Information listed on Caution Signs printed from MyChem will not be accurate if SDSs are missing.

## C. CHEMICAL PROCUREMENT

Most chemical products can be purchased from suppliers through UW Procurement Services. The RP or CHO is required to designate and/or be aware of personnel in the lab who have authority to purchase hazardous chemicals.

### 1. Hazardous Chemicals

Order only the amount of chemicals needed. Many manufacturers will supply smaller quantities or containers (if requested by the purchaser). Do not stockpile chemicals. Chemicals that are expired and/or appear to be no longer useful are considered hazardous waste. Purchase hazardous chemicals in plastic-coated bottles (when available) instead of uncoated glass bottles. Hazardous chemicals should be received directly by a laboratory or a chemical stockroom. If the chemicals are received in an office, there should be a safe location such as a designated table with adequate open space reserved for temporary storage of the package. Track orders for hazardous chemicals, and if they do not arrive when expected, attempt to follow up to confirm the location or status of the order.

When you open a shipment, you should verify that it is the correct chemical, that the container is intact, and that the date of receipt and label are legible.

### 2. Pharmaceuticals

Pharmaceuticals not regulated by the Drug Enforcement Administration (DEA), (*e.g.,* antibiotics, heparin, sterile water, and over-the-counter drugs), can be purchased through UW Medicine Drug Services (some restrictions may apply). For more information, and the pharmacy formulary list, go to the EH&S website. If you do not know exactly what pharmaceuticals to order, email questions to drugsvcs@uw.edu.

### 3. DEA Controlled Substances

DEA registrants can procure controlled substances from a drug company, wholesaler, or UW Medicine Drug Services (the preferred vendor). If you wish to order a controlled substance through Drug Services, a current Controlled Substances Registration Certificate must be emailed or mailed to Drug Services before an order can be filled. **New registrants** must complete an initial inventory upon obtaining a Controlled Substances Registration Certification prior to procuring controlled substances, and a biennial inventory for all registrants must be completed every two years, at minimum.

Controlled substances must be stored in a locked cabinet with limited access. A perpetual inventory must be maintained, and the inventory forms must meet DEA and State regulations. Expired drug(s) and waste must be kept in a secure, locked cabinet, inside a separate container, properly labeled for content and inventoried until disposal. Drug Services will provide the contact information for DEA-licensed reverse distributors required for disposal. For more information on procurement or DEA-licensed reverse distributors, contact Drug Services at drugsvcs@uw.edu.

### 4. Non-Denatured Ethyl Alcohol

Instructions for obtaining approval and purchasing non-denatured ethyl alcohol are detailed on the UW Procurement web site. Instructions for maintaining accountability for tax-free ethyl alcohol are in Administrative Policy Statement (APS) 15.1

### 5. Radioactive Materials

The State of Washington Department of Health, Division of Radiation Protection licenses radioactive materials use. Using radioactive materials requires prior approval from EH&S. Orders for radioactive materials must be placed with the UW Purchasing Department. Additional information is available on the EH&S Radiation Web page.

### 6. Highly Dangerous Materials

Materials that are extremely hazardous to property, health, or the environment (e.g., explosives pyrophoric materials, highly water-reactive chemicals, and highly toxic gases, etc.) may not be procured until the necessary administrative, engineering, and environmental controls are in place. Hazardous materials must be stored and used in accordance with numerous regulations including, but not limited to, the International Fire Code (IFC) and local amendments. (Section 2G: Special Chemical Hazards for examples). Contact EH&S at 206.685.0341 for more information.

### 7. Compressed Gas Cylinder Procurement

Gas cylinders should be purchased through the preferred supplier, Linde (a.k.a.Praxair), to ensure that the supplier has a cylinder return authorization program. Refer to the UW Procurement website.

Only order the amount of gas that you need. Some gas suppliers will not take returns of partially full or empty cylinders or containers. If a different vendor is necessary to provide a specialty gas, the purchaser must get a written return agreement from the distributor or manufacturer prior to purchasing the gas. It is important that the return agreement include a statement requiring the manufacturer to take back both the cylinder and any unused gas. The purchaser should retain this agreement until the manufacturer has accepted the returned cylinder. Additional information is available on the EH&S Web page.

### 8. Chemical Exchange

The UW Chemical Exchange program facilitates the free exchange of chemicals campus wide via MyChem, the online chemical inventory system. Consider checking the online Chemical Exchange (accessible only to UW employees) for chemicals before you buy new chemicals.

For more information about this program, visit the MyChem website.

### 9. Additional exceptions

Refer to the list of additional exceptions on the UW Procurement website.

## D. CHEMICAL STORAGE

### 1. Evaluate Chemical Hazards for Storage

Hazards due to the reactions between incompatible chemicals may include:

- Generation of heat

- Fire
- Explosion
- Toxic gas or vapor production
- Flammable gas or vapor production
- Formation of a substance with greater toxicity than the reactants
- Formation of shock- or friction-sensitive compounds
- Pressurization of closed vessels
- Solubilization of toxic substances
- Dispersal of toxic dusts and mists
- Violent polymerization

The general approach is to separate all chemicals into compatible groups. The specific SDS should always be consulted when evaluating chemical properties and hazards of the materials for storage. Most chemicals have multiple hazards; decisions should be prioritized as follows:

**a. Flammability/Explosiveness**

The most important consideration for storage is the flammability characteristic of the material. If the chemical is flammable, it should be stored in a flammable storage cabinet. Fire code allows quantities less than 10 gallons to be stored outside of a cabinet when in approved flammables containers. If the control area's total for flammables exceeds ten gallons, fire code states the flammables must be stored in a flammable storage cabinet. Working solutions can be stored outside of flammables cabinets in limited quantities. If the material is explosive, refer to the SDS or consult with EH&S to determine appropriate storage.

**b. Reactivity**

If the material will contribute significantly to a fire (e.g., oxidizers), it should be isolated from flammables. If the material will contribute significantly to a fire when water is applied (e.g., water- reactive chemicals), it should be stored to ensure it is protected from any contact with water, including water that would be applied while extinguishing a fire in the lab. Isolate materials that can react with themselves (e.g., polymerization or exothermic decomposition).

**c. Corrosives**

Corrosive substances are chemicals that cause a reaction that leads to the damage of a solid structure and should be stored below eye level. A material is considered corrosive if a liquid or solid causes irreversible destruction of human skin at the site of contact within a specified period. Review the corrosivity of the material and store accordingly.

**d. Toxicity**

The toxicity of the material, with particular attention paid to regulated materials, means that certain chemicals will be isolated within a storage area. Many toxic chemicals have additional hazards associated with them which may determine the storage area used. For example, an extreme poison that is also flammable should be locked inside the flammable storage cabinet.

## 2. Chemical Storage Practices

Establish and follow safe chemical storage and segregation procedures for your laboratory:

- Provide an appropriate storage place (per guidelines in Table 2-1 or chemical storage

pictogram in Appendix G) for each chemical and return the chemical to that location after use; note storage locations in relevant safety documents for the lab.

- Store in compatible containers.
- Do not place chemicals in household product containers, such as food containers.
- Incompatibles must not be stored together; refer to the Chemical Compatibility Chart.
- Incompatibles cannot be stored in the same hazardous materials cabinet, even if they are segregated by secondary containers, when the container exceeds 2 kg (solids) or 500 mL (liquids) or any amount of compressed gases.
- Avoid storing chemicals on bench tops.
- Avoid storing chemicals in laboratory fume hoods.
- Store volatile toxics and odoriferous chemicals in a ventilated cabinet (if available; many fume hoods have ventilated cabinets beneath the workbench).
- Do not expose stored chemicals to heat or direct sunlight.
- Storage shelves should be level, stable, and secured to the wall or stable surface. In case of an earthquake, shelves should have raised edges or rim guards to prevent containers from falling; shelves should be kept free of chemical contamination and dust sources.
- Containers should not protrude over shelf edges.
- Containers should not be stacked on top of each other, unless they are empty.
- Store heavy bottles on lower shelves.
- Store corrosives below eye level; ideally, cabinets and shelves should be sturdy and low to the floor and constructed of material that is impervious (i.e., non-reactive) with the corrosive; they should also be ventilated or located near the ventilation system.
- Containers of chemicals must be capped when not in use; make sure that caps on containers are secure; replace damaged caps. Do not use vented caps.
- If a chemical does not require a ventilated cabinet, store inside a closable cabinet or on a shelf that is anchored and that has a lip to prevent containers from sliding off.
- Chemicals should not be stored under, above, near, or in the sink to minimize the chance of accidents and improper discharges to the sanitary sewer. Any vapors of corrosive materials and bases will cause corrosion of the plumbing fixtures under the sink. Some chemicals, including many corrosives, are water reactive and in the event of a water leak, there can be unanticipated and unfortunate consequences.
- Do not store chemicals in hallways, corridors or exit ways.
- If chemicals must be stored adjacent to each other on a benchtop, use secondary containment to prevent incompatible chemicals from mixing and reacting with each other.
- Use secondary containment for spill control (generally required for containers on the floor); spill control on benchtops may involve placing the container on an absorbent pad.
- Particularly hazardous substances (highly dangerous or toxic chemicals, select carcinogens, mutagens, and teratogens) should be stored together if compatible in a designated area.

- Signs should be posted indicating chemical location and unique hazards.
- Maintain the lowest possible quantities of highly toxics.
- Chemicals with a high degree of toxicity (e.g., venoms, mycotoxins, and select agents), should be doubly contained and stored in a locked area accessible only by authorized personnel.
- Use containers that are chemically resistant and non-breakable.
- Store chemical waste following the same guidelines as above.
- Waste containers must be labeled with a completed UW hazardous waste label. If reusing a container that
- previously held another compatible chemical, the original manufacturer's label must be defaced. For more information about chemical waste, go to Section 3 of this manual.
- Use properly designed refrigerators or freezers (certified by the manufacturer for flammable materials storage) for storing volatile flammables which require refrigeration. Explosion-proof appliances are usually not required for the typical laboratory setting (refer to the EH&S website for additional information).
- If containers are placed in refrigerator/freezer door shelves, use secondary containers, additional barriers, Velcro or other protective measures to keep them from falling out when the door is opened.
- If chemicals are stored in a shared area or room, label the storage space, cabinet or container with the RP's name so that ownership can easily be identified.

***Table 2-1 Chemical Storage Recommendations***

| Chemical Classification | Storage Recommendation |
|---|---|
| **Flammables** | Store in approved safety cans or flammables cabinets. Do not store incompatible materials in the same cabinet. Keep away from any source of ignition: heat, sparks, or open flames. Flammable solids must be segregated from flammable liquids (section 2D.3). |
| **Explosives** | In general, explosives should be stored in a designated magazine. Consult with SDS or EH&S for other substance-specific storage information. |
| **Acids** | Ideally, store in a cabinet designed for acids; do not store acids on metal shelving. Segregate inorganic from organic acids. Isolate nitric acid and perchloric acid. Do not store with flammable solvents or combustibles. **Exception:** store flammable acids in the flammables cabinet and segregate them from incompatibles. |
| **Bases** | Store in corrosives cabinet or on protected shelving away from acids. Segregate inorganic from organic bases if incompatible. |
| **Light Sensitive Chemicals** | Store in amber bottles in a cool, dry, dark place. |

| Chemical Classification | Storage Recommendation |
|---|---|
| **Oxidizers** | Store in a cool, dry place away from flammables and reducing agents. Oxidizers must not be stored on wooden shelves or in cardboard boxes. |
| **Peroxidizable Chemicals** | Store in airtight containers in a dark, cool place. Most peroxidizable compounds are flammable and should be stored in a flammable chemical storage cabinet. Label containers with receipt, opening and expiration dates. Test for the presence of peroxides at least every six months. Discard before exceeding the expiration date. Inspect peroxide forming chemicals often for evidence of contamination, degradation, or any change from normal physical or chemical characteristics.<br>If you suspect a material may have become explosive, contact EH&S immediately and post a warning sign so others do not handle or disturb the material (section 4.C). |
| **Pyrophoric Substances** | Store in a cool, dry place, making provisions for an airtight seal. Materials (e.g., tert-butyl lithium) will react with the air to ignite when exposed and may require being handled under inert gas (section 2.G.d.). |
| **Toxic Chemicals** | Store according to the nature of the chemical, using appropriate security where necessary. Generally, store in a ventilated, dry, cool area in a chemically resistant secondary container (section 2.D.2). |
| **Water-Reactive Chemicals** | Store in a cool, dry location away from any water source, including sprinkler systems. For water reactive metals, have a Class D fire extinguisher available in case of fire (section G.1.e). |
| **Compressed Gas Containers** | Store in a cool, dry place, preferably outside of the building and secured with chains or other appropriate strapping material. Due to seismic concerns, full sized cylinders should be restrained at two points--two chains or straps, or one chain or strap and a floor mount. In some cases a single restraint at 2/3 height can provide adequate restraint. Note: this requirement does not apply to lecture bottles or similar small cylinders (<36”). Store lecture bottles or similar small cylinders according to their chemical contents and with regards to seismic safety. Separate flammables and oxidizers by 20 feet or a 1-hour rated firewall. |
| **General Chemicals** | Store on laboratory benches or shelves with like chemicals. Provide secondary containment on benches for liquids, and earthquake restraints for shelves (e.g., lips to prevent containers from falling off.). |

### 3. Chemical Storage Quantity Limits

#### a. Control Areas

Chemical quantities in most University buildings are limited, in accordance with the local fire code and international fire code (IFC) adopted by the local jurisdictions. (Note: Bothell, Seattle, and Tacoma Fire Departments have made amendments to IFC.) Limits by hazardous material classification apply to a control area that may include a suite of laboratories, one or more floors in a building, or the entire building. There are also outdoor control areas for storage of hazardous materials. Quantity limits may be increased if fire sprinklers protect the entire control area or, in some cases, if hazardous materials are stored in approved cabinets. Buildings under newer codes have reduced limits in control areas above the second floor. The higher the floor, the greater the reduction. Researchers and other building occupants must cooperate with each other to make sure that hazardous material quantities do not exceed code limits. This process is supported by accurate chemical inventories in MyChem. To ensure compliance with the IFC, contact EH&S at 206.685.0341.

#### b. Flammable Liquids in Basements

Flammable liquids are also limited in basement rooms to comply with the International Fire Code. The aggregate storage quantity in basement areas is limited to 75% of the Maximum Allowable Quantity (MAQ) on the -1 floor, and 50% on the -2 level. Chemical use is prohibited below the -2 level. Some storage is allowed, such as for generator tanks. Use MyChem or consult with EH&S to determine if you are exceeding MAQs.

#### c. Additional Requirements

Whenever possible, all flammable and combustible liquids should be stored within an approved flammable liquid cabinet. Small amounts may be stored outside of a flammable liquid cabinet under certain conditions or in approved containers. Quantities stored outside the flammable liquid cabinet are limited to 10 gallons per control area. This includes the overall flammable load within the control area. Contact EH&S at 206.685.0341 for guidance.

## E. CHEMICAL LABELING

Guidance and label templates for chemical containers are available on the EH&S Chemical Container Labels webpage.

### 1. Original Container

The label on an original chemical container must be legible and written in English. It must include the chemical/product name as shown on the SDS and the manufacturer's name and address. Do not accept materials if the label is illegible or missing required information. (Refer to Figure 2-1, Example of Original Label).

Labels on chemicals/products shipped from the manufacturer must be consistent with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) as required by Washington Administrative Code (WAC) 296-901-140.

There are six required WAC elements :

1. Product name
2. Manufacturer’s name and contact information
3. Signal word (e.g., “danger”, “warning” or no signal word)

4. Hazard statement(s) (e.g., toxic if inhaled, combustible liquid)
5. Pictogram(s)
6. Precautionary Statements (e.g., keep container tightly closed)

Avoid damaging the original container's label, if possible. If a container label becomes illegible, replace the label. The replacement label must include the six required WAC elements to comply with GHS rules. Contact EH&S at 206.543.7262 or ehsdept@uw.edu for assistance in obtaining a replacement label.

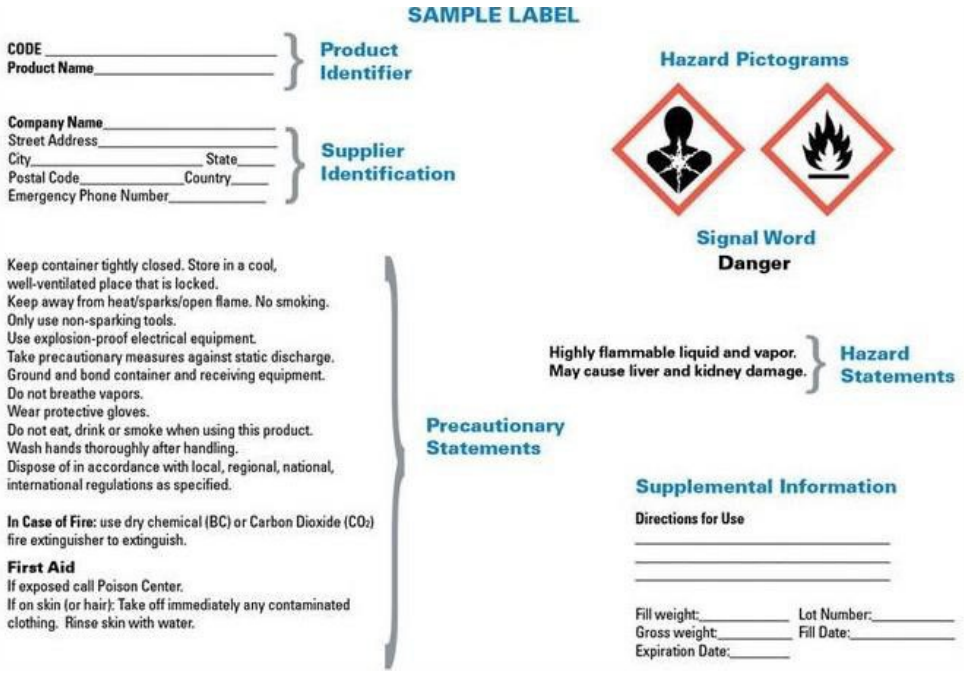


*Figure 2-1 Example of Original Label*

## 2. Labeling Stock / Working Solutions

Containers of preparations, sample aliquots and other working solutions are not required to be labeled if the container is emptied before the end of the work shift and used by only one person. If a preparation or working solution is used by others or kept longer than the first day of use, the container must be labeled with the following information:

- Identity of the contents (spell out chemical names).
- Signal word, if known or suspected (e.g., "danger", "warning").
- Hazards, if known or suspected (e.g., "flammable", "corrosive", "irritant").

It is best practice to label the working solution with the initials of the person preparing the solution and the date of preparation.

Information about the signal word, hazards, and the precautionary statements from the label can be obtained from the SDS, but dilutions and reactions may change the hazards and their severity.

Your department may require a specific type of label. If so, describe it in the laboratory-specific information section of your CHP. The method of affixing the label to the container (i.e., glue, tape, or wire) is also at the discretion of the department/laboratory.

### a. Labeling Specialized Containers

Containers that are too small for labels, installed into a process or would become unusable for their intended purpose if labeled must still have their contents identified in some way. Use any labeling method that enables employees and visitors from other agencies, such as the fire department, to identify the chemicals and their hazards. Examples include a sign identifying the materials and their hazards, colors or numeric codes cross-referenced on a chart or room diagrams identifying locations of the chemicals and hazards.

Secondary chemical labels that can be downloaded from the website and printed onto Avery labels are available on the EH&S Chemical Container Labels webpage.

### b. Additional Label Required for Peroxide-Forming Chemicals

Label chemicals that form peroxides with the date the container was received, first opened, and expected to expire using the label (UoW 1716) shown below. (General requirements for handling chemicals that form peroxides are described in section G.2.b).


*Figure 2- 2 Peroxide Label (UoW 1716)*

### c. Labeling Waste Containers

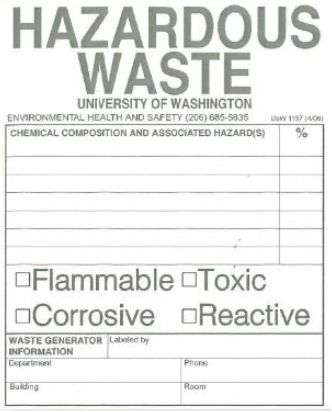


*Figure 2-3 UW Hazardous Waste Label*

Waste containers must be labeled following the guidelines in this manual (Section 3) for hazardous chemical waste. If re-using a container to hold waste, the container must be compatible and appropriate for the waste. Completely deface all old labels on containers used for waste, then affix a new label. Refer to the Empty Chemical Containers focus sheet for guidance on reusing empty chemical containers to collect chemical waste for disposal of that same chemical or compatible chemicals. Empty containers that held P-listed chemicals must be disposed of as hazardous waste, so they are not allowed to be washed or re-used (see Section 3.B.4.b)

For radioactive waste, go to Section 14 of the UW Radiation Safety Manual

For biological waste, go to section 4.F of the UW Biosafety Manual

## F. TRANSPORTING CHEMICALS

Transporting chemicals information is for moving the chemicals to other research-related locations.

Chemicals at the University are not permitted to be taken off campus to a private residence or for other purposes not related to, or approved for, institutional use.

Chemicals should be transported in a container that prevents leakage. The container should be closed. Avoid transporting chemical containers which may have contamination on the outside (*i.e.*, avoid the need to wear gloves or other PPE while transporting chemicals). If the container is breakable, it should be placed in a secondary container.

### 1. Transporting between Floors and Buildings on Campus

This section applies to transportation by hand or by cart. In general, when possible, use freight- only elevators when moving chemicals between floors.

#### a. Moving a Single Chemical

1. The person doing the moving must be trained in the hazards of the chemical and know what to do in the event of a spill of that chemical.
2. The exterior of the container must be clean enough that it may be handled without the need for protective gloves.
3. Chemical bottles must be labeled appropriately (refer to Section 2E), securely capped and placed in a bottle carrier.
4. Chemical containers that are glass and do not have closing caps or handles should be placed in closed bottle carriers or larger containers and surrounded by vermiculite or other absorbent material.
5. When moving a compressed gas lecture bottle, do so in a manner that protects the valve. Larger gas cylinders must be moved using precautions listed in Section 2.G.9.c below.
6. Whenever possible, use freight elevators to transport chemicals. If no freight elevator is provided, passenger elevators may be used, but passengers should be discouraged from travelling with liquid and solid materials. Passengers (other than the material handler) are not allowed in elevators with compressed gas and cryogen transport.

#### b. Moving Multiple Chemicals

1. The person doing the moving must be trained in the

hazards of the chemicals and what to do in the event of a spill of those chemicals.

2. The person must also have a spill kit that can handle the spill of those chemicals.
3. The exterior of the containers to be moved must be clean enough that they can be handled without the need for protective gloves.
4. Chemical containers must be labeled appropriately (refer to Section 2E) and securely closed. Lecture bottles should be packed in a manner that protects the valve.
5. Chemicals should be grouped by compatibility and by hazard class (e.g., flammable, toxic, etc.), and each group should be placed in larger containers or tubs while being transported.
6. Containers used to transport multiple chemicals should be lined with an absorbent material such as vermiculite to cushion the load and absorb and contain any spills. Multiple glass bottles in the same tub should be cushioned using the absorbent material to prevent the bottles from rattling against each other.
7. Carts used to move chemicals should be stable under the load and have wheels large enough to negotiate uneven surfaces without tipping or stopping suddenly.
8. For laboratory moves across campus, EH&S can arrange for a contractor to pack and move your chemicals for you at your expense, or you can pack and move them yourself using proper DOT packaging and a UW Motor Pool vehicle. (Refer to Section 10.B.2 of this manual for details).

## 2. Transporting Chemicals off Campus

Transporting chemicals information is for moving the chemicals to other research-related locations. Chemicals purchased for laboratory use should not be taken off campus for non-institutional use.

Refer to the UW Field Operations Safety Manual for guidance on using chemicals for field research.

### a. Vehicle Use

Transport certain hazardous materials in UW-owned and operated Motor Pool vehicles. You cannot transport hazardous chemicals in your personal vehicles without prior authorization by the UW. For more information or for authorization, call 206.616.5835 or email chmwaste@uw.edu. If you are transporting chemicals for a lab relocation, please read F.2.d below.

### b. Shipment by Others

If you ship hazardous materials by vehicle or air, you are required by law to be trained and certified (Section 2.F.3.a). This includes situations when you use a commercial contractor (FedEx, United Parcel Service, Yellow Freight, etc.) to transport hazardous material for you. You are responsible for complying with all applicable transportation

regulations (which ensure the safety of your chemicals as well as those who transport them) and providing an SDS for each chemical.

### 3. Receiving Chemical Shipments

Inspect all incoming shipments to ensure proper labels are attached, accurate, and that the containers are intact and in good condition. Any leaking containers must be placed in an appropriate, secondary container and treated as a chemical spill. Call EH&S for spill procedures at 206.543.0467 (M-F, 8:00 a.m.-5:00 p.m.) Outside of business hours, call UWPD at 206.685.UWPD, and ask for the EH&S staff person on call. If you receive a shipment container that appears to be bulging or pressurized, isolate the package, if possible, and do not open the container. **Call 911** immediately.

#### a. Training: Shipping Hazardous Materials

Training is required for all people who classify, prepare, package, label, document, or offer a hazardous material for transport. Shippers can receive training by taking the EH&S Shipping

Hazardous Materials course. Class times and registration can be found on the EH&S website.

#### b. Laboratory Moves

EH&S will arrange to have a contractor package your chemicals and transport them to your new location if off-campus. The lab is responsible for the expense, and there are some materials the contractor cannot transport (temperature restrictive materials, DEA regulated materials, and radioactive, infectious, or explosive materials). Go to Section 10.B.2 for details. For more information, call 206.616.5835 or email chmwaste@uw.edu.

## G. SPECIAL CHEMICAL HAZARDS

### 1. Highly Dangerous Chemicals

Highly dangerous chemicals present exceptional risks due to flammability or reactivity. At the UW, highly dangerous chemicals are those that are explosive, unstable, self-reactive, self-heating, oxidizers, water-reactive, organic peroxides, and pyrophoric. EH&S flags Particularly Hazardous Chemicals, which include highly dangerous chemicals, in MyChem based on hazards entered in MyChem corresponding to the Fire Code and the Globally Harmonized System for Classification and Labeling. Refer to the criteria on the EH&S website for more information.

### 2. Particularly Hazardous Substances

Personnel need to take special precautions with chemicals that are reactive, explosive, highly toxic, select toxins, carcinogens, reproductive hazards, sensitizing or allergenic, synthesized chemicals, in compressed gas cylinders or at high pressure, exceptionally flammable, or federally regulated and have additional specific requirements. If the degree of hazard is serious enough, the chemical is classified as a particularly hazardous substance (PHS).

PHSs at the UW are those that present extreme hazards to personnel and property and require stringent safeguards. PHSs include chemicals considered to be highly toxic, highly dangerous, a reproductive toxin, a select carcinogen, or a select toxin.

Work with PHSs requires specialized training from your PI or supervisor, and customized standard operating procedures that identify designated work areas,

containment devices such as fume hoods and glove boxes, procedures for decontamination protocols and prior approvals before work begins.

Particularly hazardous substances are identified with a letter in the REG column of your MyChem inventory. Explanations of identification letters and the criteria for classification are shown on the EH&S Web page for particularly hazardous substances.

The number of chemicals flagged in MyChem as PHSs will grow as new chemicals are added to UW inventories and the knowledge about chemical hazards continues to evolve. We recommend you review SDSs and other sources of hazard information to determine if other chemicals in your work area fall within this criteria and require these additional safeguards.

Expanded precautions for use include:

- Improve the security and integrity of chemical storage.
- Identify designated work areas for usage of the chemical.
- Review proposed procedures by another PI.
- Conduct intensive training on the chemical's hazards and the equipment used.
- Require increased proficiency be demonstrated and documented before any particular individual may perform the procedures .
- Require a second lab worker to be in the lab in case of emergencies.
- Ensure all safety measures are included in the SOPs.
- Check that additional measures for shipping such materials have been confirmed.

EH&S flags PHS in MyChem based on these chemical hazards utilizing the Fire Code and the Globally Harmonized System (GHS) for Classification and Labeling. The specific criteria utilized can be found on the EH&S website. EH&S also utilized information found in the National Institutes for Occupational Safety and Health (NIOSH) List of Antineoplastic and Other Hazards Drugs in a Healthcare Setting and the EH&S Guidance on Workplace Hazards Impacting Reproduction and Development. EH&S flags PHSs in MyChem based on these chemical hazards utilizing the Fire Code and the Globally Harmonized System (GHS) for Classification and Labeling. EH&S also utilized information found in the National Institutes for Occupational Safety and Health (NIOSH) List of Antineoplastic and Other Hazards Drugs in a Healthcare Setting and the EH&S Guidance on Workplace Hazards Impacting Reproduction and Development.

### 3. Reactive Chemicals

A chemical is considered reactive if it has *the capability to undergo violent chemical change,* such as explosions or production of toxic fumes, in certain situations. Purchase and use these chemicals in small quantities or find a suitable alternative. Take extreme care when handling and storing these compounds. Chemicals with an NFPA rating of three or four for reactivity are considered particularly hazardous substances due to being highly dangerous. Extra precautions taken (as described in Section 2.G) need to be documented in your SOPs.

#### a. Compounds that Generate Toxic Gases

Some compounds that contain sulfide or have a cyanide (-CN) functional group can

generate toxic gases in sufficient quantities to present a danger to human health when combined with other compounds, such as hydrochloric acid.

#### b. Oxidizers

Oxidizers are chemicals that initiate or promote combustion of other materials. Oxidizing agents include halogenated inorganics, nitrates, chromates, persulfates, and peroxides. Several accidents have occurred at the University due to waste oxidizers being disposed into common waste receptacles under the mistaken belief that the oxidizer would no longer react with the other waste chemicals.

#### c. Chemicals that may Polymerize

Polymerization is a chemical reaction in which small molecules combine to form larger molecules. Polymerization can be hazardous when the reaction releases large amounts of energy or drastically increases the volume of the chemical.

#### d. Pyrophoric Chemicals

A chemical that will ignite spontaneously in air at or below 130 °F (54°C) is considered pyrophoric. The oxidation of the compound by oxygen in the air proceeds so rapidly that ignition occurs spontaneously. Such chemicals would be considered particularly hazardous substances and the extra precautions taken (as described in Section 2.G above) need to be documented in your SOPs.

#### e. Water Reactive Chemicals

Water reactive chemicals react violently with water to release a gas that is either flammable or presents a health hazard. Alkali metals, many organometallic compounds, and some hydrides react with water to produce heat and flammable hydrogen gas. Some of these reactions proceed so violently that the chemicals are classified by NFPA as Reactive code three or four, and the extra precautions taken (as described in Section 2.G above) need to be documented in your SOPs.

#### f. Self-reactive Chemicals

Self-reactive chemicals are thermally unstable liquid or solid chemicals liable to undergo a strongly exothermic decomposition even without participation of oxygen (air). Chemicals classified as explosives, organic peroxides, oxidizing liquids or oxidizing solids may be self-reactive, but should be handled according to those classifications. A self-reactive chemical may possess explosive properties, even if not classified as explosive, due to its ability to detonate, to deflagrate rapidly or to show a violent effect when heated under confinement. Additional information on certain self-reactives is found in the following section. Certain self-reactive chemicals may be classified as particularly hazardous substances and the extra precautions taken (as described in Section 2.G above) need to be documented in your SOPs.

### 4. Potentially Explosive Chemicals

An explosive chemical, when subjected to heat, impact, friction, or electric or chemical charges can produce a sudden, quick release of pressure, gas, and heat. When detonated in an uncontrolled or unexpected circumstance, explosives can result in serious bodily harm or extensive property damage. Shock sensitive explosives are known to detonate even when bumped or handled normally. Common potentially explosive chemicals at the UW include:

#### a. Nitrated Compounds

Nitrated organics and inorganics constitute the largest class of compounds that are explosive when dehydrated.

When you purchase a nitrated compound, do so in small quantities. Weigh the container and write the weight on the bottle. Do not break the seal on the cap until the chemical is in active use. Prior to subsequent use, weigh the container again. If the container weighs less, add an appropriate solvent to replace the weight lost. After the reagent is opened and an aliquot is taken, note the weight of the container. Visually inspect the container for problems prior to each use, and wipe down the bottleneck, cap, and threads with a wet cloth before resealing. Additional factors that need to be included in your SOPs are described in Section 2.G (above).

Picric acid is a nitrated compound usually purchased as a solid wet with 10% water. Extreme heat, blasting cap, or electric charge can detonate picric acid. It becomes highly unstable if allowed to dehydrate. When wet, picric acid is an orange colored, compact crystalline solid with the consistency of lumpy sand. When dry, picric acid is a crystalline solid with visible air pockets below the surface.

Picric acid will readily form explosive metal picrates, which are extremely shock sensitive and will detonate with the slightest movement or vibration. Do not allow picric acid to contact metal that is readily oxidized or to be stored in a container with a metal cap. Lead, iron and copper metals are particularly dangerous due to metallic picrate formation.

**b. Organic Peroxide-Forming Solvents**

Organic peroxide-forming solvents become shock sensitive when allowed to oxidize and form appreciable quantities of explosive peroxides. Most of these solvents are also flammable. Most peroxide forming solvents are colorless, mobile liquids. Oxidation can occur when the solvent is exposed to atmospheric oxygen. This reaction is catalyzed by light as well as by temperature and pressure changes.

The additional precautions you take to control peroxide-forming hazards (described in Section 2.G above and in this section) need to be documented in your SOPs. For more information, the Peroxide Forming Chemicals Management and Assessment Guidelines are online.

**c. Procedures for Peroxides**:

1. Highly Concentrated Peroxides - Over time, peroxide concentrations can increase to hazardous levels. Solvents with high concentrations of peroxides will appear viscous or contain needle-like crystals. If peroxides are visible, no further handling is recommended. Contact EH&S at 206.616.5835 for assistance with professional testing and stabilization.
2. Explosive Capability - Peroxides formed in organic solvents have caused some laboratory accidents, including unexpected explosions during distillation and use. Such formulations are considered low-powered explosives; they will detonate in moderate concentrations by modest shock, friction, or when heated. The biggest dangers of organic peroxides in these solutions are opening the container and distilling. Do *not* open or move the container if there are crystals on or around the container cap. Call EH&S at 206.616.5835 for assistance if you are concerned about opening the container
3. Handling Procedures - Label the container with the date received, opened,

and of expected expiration. Label the container with the standard peroxide label (UoW 1716; Figure 2-4). Do not break the seal on the container until the solvent is needed. Once opened, store solvent in an airtight amber glass bottle or metal container, with an inert gas, such as nitrogen, in the headspace.

4. Testing Peroxides - It is best laboratory practice to use test strips to test the solvent for peroxides on a routine basis and prior to each use past the date of expected expiration. Record test dates on the container label. After each use, wipe down the bottleneck, cap, and threads with a cloth before resealing. Reduce formed peroxides and add an inhibitor (as necessary) to keep the concentration of peroxides below 10 ppm. Extreme caution should be exercised if concentrations of peroxides exceed 30 ppm. Test and treatment methods available at EH&S 206.616.5835

5. Distillation and Evaporation Precautions - Always test for peroxides before distillation or evaporation because these procedures will increase the concentration of any peroxides present. Record test dates on the container label. Do not distill or evaporate solvents containing any amount of peroxides. Use a water bath over a hermetically sealed electrical mantle to safely heat the solvent. Use any distilled solvent immediately or add an inhibitor .


*Figure 2-4 Peroxide Label (UoW 1716)*

6. Use of Inhibitors – Inhibitors slow the formation of peroxides in the future. They do not reduce or remove peroxides already present. Organic peroxides should be reduced safely.

7. Monitoring Expiration Date – An expiration date is required to be listed on the container label of the chemical. If a date is not listed by the manufacturer, calculate the maximum retention time based on the hazard level and chemical composition (guidance provided in the Peroxide Forming Chemicals Management and Assessment Guidelines document and Table 2.2 shown below) and list it on the container as the expiration date. The maximum retention times begin on the date of opening a manufacturer's bottle or the date of synthesis in your laboratory. Use the solvent before the manufacturer's expiration date or the maximum retention time. Peroxide-forming solvents exceeding their expiration date cannot be discarded through EH&S until the contents have been tested for peroxides.

***Table 2-2 Peroxide-Forming Chemicals Maximum Retention Times****

| Severe Hazard | High Hazard | Moderate Hazard |
|---|---|---|
| **3 months**<br>Once exposed to oxygen rapidly oxidizes, forming explosive peroxides. | **6 months**<br>Once exposed to oxygen, oxidizes at a moderate rate forming explosive peroxides. | **12 months**<br>Once exposed to oxygen, slowly oxidizes forming explosive peroxides. |
| Diisopropyl ether<br>Divinylacetylene<br>Potassium amide<br>Potassium metal<br>Sodium amide<br>Vinylidene dichloride (1,1-Dichloroethylene) | Acetaldehyde<br>Cumene<br>Cyclohexene<br>Cyclopentene<br>Diethyl ether<br>Di-n-propyl ether<br>p-Dioxane<br>Furan<br>Methyl isobutyl ketone<br>Tetrahydrofuran<br>Vinyl ethers | Ethylene glycol ethers<br>Ethyl vinyl ketone<br>Oleyl alcohol<br>Tetrabutylammonium fluoride |

*This table includes common peroxide-forming chemical but is not comprehensive

#### d. Azides

Both organic and inorganic azides, (R-N3), can be heat- and shock-sensitive, and explosively decompose with little input of external energy. Some azides may also be self-reactive. Sodium azide (NaN3) and other metal azides are highly toxic and should be handled with care and appropriate PPE. Care should be taken to avoid metals and metal salts when working with or disposing of inorganic azides, as most metal azides have the potential to be explosive and should be protected from light, shock, and heat. Metal azides react with strong acids to generate hydrazoic acid (HN3), which is a highly toxic and highly explosive gas. Dichloromethane and chloroform solvents should be avoided, as metal azides may react with these solvents to form highly explosive azidomethanes.

Organic azides can be sensitive to violent decomposition from external energy sources such as light, heat, friction, and pressure. This potential reactivity is greater when the N to C ratio is higher. A good rule of thumb is that azides with an N to C ratio greater than 1:3 should be treated with extra caution. Certain azides may be classified as PHSs. Document additional precautions (described in Section 2.G above) in your SOPs.

#### e. Fulminates

Fulminates are compounds that contain a carbon-nitrogen-oxygen group. Metal fulminates such as mercury, silver, and gold are highly explosive. Explosions are typically initiated by heat. Silver fulminates can form in un-discarded Tollens reagent. Certain fulminates may be classified as PHSs. Document additional precautions (described in Section 2.G above) in your SOPs.

### 5. Highly Toxic Substances

#### a. Precautions for Use

In laboratories, particularly hazardous substances (PHSs) identified in MyChem include

chemicals that are highly toxic. The procedures for using such chemicals require additional precautions (as described above in Section 2.G).

**b. Categories of Highly Toxic Chemicals**

Various regulatory agencies define highly toxic chemicals differently.

The IFC defines "highly toxic and poisonous materials" for signage and fire code reasons. Refer to the current IFC Chapter on Highly Toxic and Toxic Materials for additional information about these codes and requirements.

The EPA and Washington State Department of Ecology have other criteria for classifying a chemical as "extremely hazardous" or a "substance with high acute toxicity." These definitions affect their reporting requirements and waste accumulation and disposal requirements.

The Washington State Department of L&I has adopted the following Globally Harmonized System for Hazard Management criteria to identify highly toxic chemicals: Washington Administrative Code 296-901.

For reference, $LD_{50}$ (Lethal Dose – 50%) is a single dose of a material expected to kill 50% of a group of test animals. $LC_{50}$ (Lethal Concentration – 50%) is a calculated concentration of a material in air or water, exposure to which for a specified length of time is expected to cause death of 50% of a defined experimental animal population.

1. Dermal Route

The median lethal dose ($LD_{50}$) for dermal route is less than or equal to 200 milligrams per kilogram (mg/kg) of body weight when administered by continuous contact for 24 hours (or less) with the bare skin of albino rabbits weighing between two to three kilograms each.

2. Oral Route

For an oral route, the median lethal dose ($LD_{50}$) is less than or equal to 50 mg/kg of body weight when administered orally to albino rats weighing between 200 to 300 grams each.

3. Inhalation Route

The median lethal concentration ($LC_{50}$) for an inhalation route is less than or equal to 200 parts per million (ppm) for gases and two milligrams per liter of air (mg/l) for vapors, dusts, mists or fumes where time of exposure is any time up to four hours when administered to albino rats weighing between 200 to 300 grams each.

The Centers for Disease Control and Prevention (CDC) recognizes highly toxic "select agents and toxins." Information and the regulation pertaining to select agents and toxins are available on the CDC website. Select agents and toxins are only allowed in specific spaces on campus and must only be used by approved individuals. If you intend to use any of these select agents and toxins, pre-approval is required before obtaining them. Please contact EH&S at 206.221. 7770 to initiate the approval process.

## 6. Carcinogens and Reproductive Hazards

Additional care must be taken to minimize exposures to known and suspected carcinogens and reproductive hazard chemicals, including teratogens, because inadequate information is available in many cases. Steps to minimize exposures

include: substituting for less hazardous chemicals if possible, using the smallest amounts necessary, and using a fume hood or other engineering control system. Additional information is available on the EH&S Reproductive Hazards webpage.

**a. Select Carcinogens**

Various peer group agencies have researched data and compiled lists of known, suspected and/or regulated carcinogens. A select carcinogen is any chemical that meets one of the following criteria:

- The Washington Department of L&I regulate it as a carcinogen.
- It is listed as "known to be human carcinogens" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition.)
- It is listed as Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer (IARC) Monographs (latest edition as of June 26th, 2015, IARC monograph volume 113.)
- It is listed in either Group 2A ("Probably carcinogenic to humans") or 2B ("Possibly carcinogenic to humans") by IARC or in the category of "Reasonably anticipated to be human carcinogens" by NTP, and it causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: after inhalation exposure of six to seven hours per day, five days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3; OR after repeated skin application of less than 300 mg/kg of body weight per week; OR after oral dosages of less than 50 mg/kg of body weight per day.

**b. Reproductive Toxicants**

Reproductive toxicants are those known to affect human reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis). In "Workplace Hazards to Reproduction and Development: A Resource for Workers, Employers, Health Care Providers, and Health & Safety Personnel," 1999, by Sharon L. Drozdowsky and Stephen G. Whittaker, Technical Report Number 21-3-1999, Washington State Department of Labor and Industries, Safety and Health Assessment and Research for Prevention (SHARP) Program, Tables H-1 and H-2 include those human reproductive toxicants listed as "A+" through "A". Chemicals rated "A+" and "A" are listed as "Reproductive Toxicants, and those rated "A" are listed as "Suspected Reproductive Toxicants." General information about potential reproductive and developmental hazards, and advice on safe work conditions and practices in their work environment is available on the EH&S website. The guidance addresses both female and male reproductive health risks, and it contains details on identifying, evaluating, and reducing those workplace risks.

**c. Select Toxins**

Select toxins at certain threshold levels, as listed on the Federal Select Agent Program website, are regulated if they have a potential to pose a threat to public health and safety. If used on the UW campus, additional requirements for registration, handling and disposal are required. Refer to the EH&S Select Agent Program website for more information or contact EH&S at 206.221.7770.

### d. Hazardous Substances

Hazardous drugs, as defined and listed by the National Institute for Occupational Safety and Health (NIOSH), include those that exhibit one or more of the following six characteristics in humans or animals:

- Carcinogenicity.
- Teratogenicity or other developmental toxicity.
- Reproductive toxicity.
- Organ toxicity at low doses.
- Genotoxicity.
- Structure and toxicity profiles of new drugs that mimic existing hazardous drugs.

These include drugs used for chemotherapy (also called antineoplastics), antiviral drugs, hormones, some bioengineered drugs, and other various drugs. Many of these substances do not have a known safe exposure or "no effect" level. Federal and state regulations and guidelines exist for the use, handling, storage, treatment, and disposal of hazardous drugs in clinical and research settings.

Follow safety precautions when working with these hazardous drugs. These include use of exhausted enclosures, procedures to avoid personal exposure and contaminating surfaces, PPE, and training of personnel in hazard awareness and safe work practices. For more information, go to the Chemotherapy and Hazardous Drugs webpage.

## 7. Sensitizing or Allergenic Chemicals

Potent chemicals which can cause sensitization or allergy may affect researchers by changing their style of life and, in some cases, force them to leave their areas of research. This hazard is not limited to traditional laboratory chemicals; researchers handling animals can become allergic to animal dander; and researchers in forest resources can develop allergies to molds. Examples are shown in Table 2-3.

***Table 2-3 Sensitizing or Allergenic Chemicals***

| Sensitizing or Allergenic Chemicals | | |
|---|---|---|
| Beryllium | Chromium | Isocyanates |
| 1,2,4-Benzenetricarboxylic anhydride | Diazomethane | Latex |
| Bichromates | Formaldehyde | Nickel |
| 1,2-Cyclohexanedicarboxylic anhydride | Gluteraldehyde | Phenols (certain types) |

Once sensitized, a person may react to extremely low amounts of the chemical. Response can range from contact dermatitis to anaphylactic shock.

Use caution to minimize exposures. Situations that may lead to acute exposure (e.g., cleaning up a spill) are required to be carefully assessed to keep the exposure at a safe level. If a person is sensitized or allergic to a similar chemical, any control which will prevent exposure to the chemical should be implemented (e.g., improved ventilation, barriers, or improved procedures). If respirators are used, the person must comply with all steps in the UW Respiratory Protection Program.

## 8. Synthesized Chemicals

Synthesized chemicals may present unexpected hazards. The first step should always be to perform a literature review for information on the expected hazards from the proposed procedures and the known hazards of chemicals with similar structure. Take into account that all these hazards are being assumed for the new, synthesized chemicals and additional hazards may arise.
Pay particular attention to hazards from reactions or during purification or subsequent activities. Generate minimal quantities until the basic hazards of the chemical can be determined.

### a. Nanoparticles

The term "nanoparticle" defines particles with at least one dimension less than 100 nanometers. They may be deliberately engineered or develop naturally. Some chemicals may be more reactive and toxic at this particle size than bulk-sizes. Take special care to prevent them from being released into the environment. If your laboratory intends to create aerosolized nanoparticles, measure the typical nanoparticle levels before the process begins and compare it to subsequent levels. Additional information about nanoparticle safety guidelines is available on the EH&S the website or by contacting the UW CHO at: labcheck@uw.edu

### b. Providing Synthesized Chemicals to Others

If you produce a chemical substance for use by another agency outside the UW system, the Hazardous Chemicals in Laboratory standard (WAC 296-828) requires that you produce a label and a Safety Data Sheet for that substance in accordance with the Globally Harmonized System for Hazard Communication outlined in WAC 296-901, SDS and Label Preparation.

A laboratory synthesizing chemicals for use by others should consider themselves a resource responsible for providing hazard cautions to those receiving the chemical. Personnel synthesizing a hazardous chemical should provide other parties with as much information about the safety precautions when using the chemical as is feasible. For more information, please contact the UW CHO: labcheck@uw.edu.

## 9. Compressed Gases, Gas Cylinders and Liquid Cryogen Containers

Gas is a generic term describing compressed gases, liquefied compressed gases, refrigerated liquefied gases (cryogenic gases), and dissolved gases. Non-liquefied compressed gases do not become liquid at normal temperature, even at high pressures. Liquefied compressed gases become liquid at normal temperatures when pressurized in a gas cylinder. Refrigerated liquefied gases, also known as cryogens, become liquid at very low temperatures. The cryogenic gases have boiling points below -150°C. Dissolved gases are gases dissolved in other substances while stored in gas cylinders. Additional details on safety practices and requirements are available in the EH&S Compressed Gas Cylinders Safety Guidelines on the EH&S Compressed Gases webpage.

### a. Hazards of Compressed Gases

1. Both physical and health hazards are present with the use of compressed gases. The high pressure in cylinders (> 900 PSIG) makes the gas cylinder a potential physical explosive rocket that could punch through walls.
2. Some gases may be corrosive which could result in damage to tissue and/or

equipment at the point of contact.

3. Cryogenic gases have dangerously low temperatures, have the potential to cause frostbite, and may expand into large volumes of gas that could displace oxygen and result in suffocation.
4. Inert gases and oxidizing reactions may create oxygen deficiency hazards (ODH) by displacing oxygen and may lead to suffocation. The early symptoms may be dizziness and weakness, which may lead to unconsciousness and death. This is also termed asphyxiation.
5. Flammability of gases, which could result in fires, is a concern especially for Acetylene, Hydrogen, and Propane.
6. The permissible exposure limits (PEL) for toxic materials may be very low, so even a small exposure could be poisonous.
7. Oxygen leaks may create oxygen-enriched atmospheres which increase the risk of fire and explosions.
8. Additional hazards may be found on the gases' SDSs.

**b. Safe Practices**

Adhere to the following safe practices when working with compressed gas cylinders and cryogen containers:

1. Make sure cylinders have proper labels including contents, concentrations, hazard classifications, safety precautions, manufacturer or supplier's name, and a tag that indicates whether the cylinder is "full", "in-service", or "empty." Accept only properly identified cylinders. If the cylinder is not properly labeled, or the label cannot be read, return the cylinder to the supplier.
2. Make sure gas cylinders are not damaged and do not show signs of corrosion. If you notice they have damaged labels, dents, gouges, burn/heat marks, or show signs of corrosion, then do not accept them and return them to the supplier.
3. Assume all cylinders contain gas under pressure, and treat all gases as hazardous chemicals.
4. Clearly label all gas lines leading from gas cylinders. This is especially important if the cylinder cannot be seen from the application point. Markings used for piping systems must include the content's name and direction of flow arrow. Markings are required at each valve, at wall or ceiling penetrations, at each change of direction and at a minimum every 20 feet throughout the piping run.
5. Use, store and transport cylinders in an upright position unless they can be safely stored horizontally.
6. Use cylinders in a well-ventilated area. If you need to use a gas cylinder in spaces with inadequate ventilation confer with EH&S at 206.543.7388 to conduct a hazard assessment. Spaces with poor ventilation may need oxygen alarms or ventilation failure alarms.
7. Secure cylinders properly during storage, transport and use to avoid knocking

over cylinders (read 2.G.9.c below for additional transport requirements).

8. Make sure caps are in place when the cylinder is not in use and during transport.
9. Make sure access to the cylinder valve is unobstructed at all times.
10. Make sure pressure regulators are equipped with pressure release valves.
11. When turning off the cylinder, turn the gas supply off at the cylinder valve first, de- pressurize the system and then turn off the regulator. If the cylinder will not be used on a consistent basis, remove the regulator and replace the cylinder cap.
12. Keep incompatible gases stored separately. If the cylinder is not in use, separate oxidizing gases from flammable gases by 20 feet or a one-hour firewall. *Note:* one backup cylinder stored in the area with the one in use may also be considered in use and not subject to incompatibility storage requirements.
13. Store highly toxic gases in exhausted enclosures (gas cabinet or fume hood).
14. Avoid sources of ignition and open flame.
15. Do NOT purchase more or larger cylinders than necessary.
16. Do NOT store or use compressed gas cylinders or cryogenic dewars in corridors. Refer to the UW Corridor Policy.
17. Do NOT store flammable gases next to an exit or near oxygen cylinders.
18. Do NOT use or permit contact of solvents, oil or grease on cylinders or their valves.
19. Do NOT empty gas cylinders to a pressure lower than 25 psi (172 kPa). At lower pressures, suction and backflow can cause contamination of residual contents with air if the valve is open. Do NOT use Teflon tape on cylinder or tube fitting connections, which have metal- to-metal face seals or gasket seals.

### c. Moving Compressed Gas Cylinders

When moving compressed gas cylinders, you must:

- Disconnect regulators and other apparatus prior to transport.
- Install the valve cap if the cylinder has one.
- Install the cylinder cap if the cylinder has one.
- Secure the cylinder in a cart or container designed to prevent the cylinder from falling over while being moved.

Whenever possible, use freight elevators to transport full, compressed gases. If no freight elevator is available, passenger elevators may be used. Passengers (other than the material handler) are *not* allowed in elevators with compressed gas and cryogen transport.

For more information, refer to the Gas & Cryogen Transport focus sheet.

### d. Leaking Gas Cylinders

Do not over-tighten the valve in an attempt to stop the leak. If the valve continues to leak, consider whether room evacuation and building evacuation is necessary. Take the following actions as appropriate:

1. Flammable, oxidizing or inert gases – Wear PPE as necessary. If possible, allow the cylinder to exhaust into a well-ventilated area (such as a fume hood) with few or no combustible absorbent materials in the vicinity (such

as cardboard). Post a sign warning of the leaking cylinder. Avoid sparks and open flames.

2. Toxic or corrosive gases – Wear PPE as necessary. Exhaust cylinder into an absorbent or neutralizer if possible. If no absorbent or neutralizing system is available, exhaust the cylinder into an operating fume hood. If escaping gas is leaking out of the control device or no control device is available, evacuate the area. Post a sign warning of the leaking cylinder.

**e. Compressed Gas Piping and Tubing**

Permanent and temporary gas piping systems are used for compressed gases. Entire buildings may only contain permanent gas piping systems; temporary gas piping systems should be as short as possible in one room. (For additional information visit the Compressed Gas webpage.

**f. Regulators**

Pressure regulators lower gas pressure to a usable level. There are two different types of regulators and specific precautions must be in place prior to use.

**g. Compressed Gas Shipments**

Researchers should purchase compressed gas through the UW preferred supplier, Linde (f.k.a. Praxair). (Section 2.C.7). When the gas arrives, inspect the cylinder to make sure it's what you ordered. Never accept a cylinder with damaged labels, dents, gouges, or burn/heat marks.

**h. Returning and Disposing of Gas Cylinders**

Whenever possible, gas cylinders should be returned to the supplier as described in section 2.C.7 concerning procurement of gas cylinders. (Additional information on cylinder disposal is described

in Section 3.P of this Laboratory Safety Manual). If returning full or partially full cylinders, review shipping precautions on the Compressed Gas webpage.

**i. Anesthetic Gases**

Anesthetic gases can be separated into two categories: Halogenated anesthetic gases/vapors and nitrous oxide. Halogenated anesthetic gases/vapors are commonly used during veterinary care or experiments in animal research. For more information on the potential health hazards and methods of controlling exposures to anesthetic gases, refer to the UW Anesthetic Gases Safe Use Guidelines.

## 10. Flammable and Combustible Liquids

Read the SDS for safety precautions before handling flammable and combustible

liquids. Know the flash points of the flammable or combustible materials you are using. The flash point is defined as: "the lowest temperature at which a chemical can vaporize to form an ignitable mixture with air." Many common organic solvents and chemicals used in the laboratory have flash points well below room temperature. At or above the flash point temperature, there can be sufficient vapor to ignite if an ignition source is present. Flammable liquids are defined as: "having a flash point less than 100 °F (37.8 °C)". Combustible liquids have a flash point of 100 °F or higher but can still produce enough vapor to burn if heated.

Highly flammable chemicals with an NFPA rating of four for flammability are also

considered PHSs and need additional precautions (as described Section 2.G above). Remember to plan for an emergency by adhering to the precautions in Section 9.A.2.c, such as preventing clutter, wearing lab coats that resist burning, and providing clear access to eyewashes, emergency showers, and evacuation routes.

The main objectives in working safely with flammable liquids are to avoid accumulation of vapors and to control sources of ignition.

### a. Vapor Control

Substitute with less hazardous chemicals whenever possible. Use the smallest amount of flammable liquid necessary for your procedure. Use closed systems whenever possible. If you must work with open systems, use a fume hood to prevent accumulation of flammable vapor. Close the fume hood sash when flammable chemicals are still present, even when not performing your procedure.

Each flammable liquid has two limits: Lower Flammability Limit (LFL) and Upper Flammability Limit (UFL) defining the range of concentrations in mixtures with air that will propagate flames or explode. These limits are also sometimes referred to as the Lower Explosive Limit (LEL) and the Upper Explosive Limit (UEL). The range that a fire or explosion could occur becomes wider with increasing ambient temperature and in oxygen enriched atmospheres. In Table 2-4 (below), Flash Points, Auto-Ignition Temperatures and Flammability Limits, the ranges of LFL to UFL, are shown for typical laboratory chemicals.

***Table 2-4 Flash Points and Flammability Limits of Certain Chemicals***

| Chemical | Flash Point °C / °F | Auto-Ignition Temperature °C / °F | Flammability Limits (% volume in air) | |
|---|---|---|---|---|
| | | | Lower (LFL) | Upper (UFL) |
| Acetone | -37.8 / -36 | 465 / 870 | 4 | 60 |
| Benzene | -11.0 / 12 | 560 / 1040 | 1.3 | 7.1 |
| Carbon disulfide | -30.0 / -22 | 80 / 176 | 1.3 | 50 |
| Diethyl ether | -45.0 / -49 | 160 / 320 | 1.9 | 36 |
| Ethanol | 12.8 / 55 | 365 / 690 | 3.3 | 19 |
| Methanol | 11.1 / 52 | 385 / 725 | 6.7 | 36 |
| Methyl ethyl ketone | -6.1 / 21 | 516 / 960 | 1.8 | 10 |
| Pentane | -40.0 / -40 | 260 / 500 | 1.5 | 7.8 |
| Toluene | 4.4 / 40 | 480 / 896 | 1.2 | 7.1 |

If you are warming flammable liquids above the auto-ignition temperature, make sure there is no exposure to air or oxygen until the temperature drops below the auto-ignition temperature (such as those shown in the table above). Make sure the ovens are specifically designed for flammable liquids (no internal ignition sources and/or are vented mechanically).

If you need to heat flammable liquids, use devices that have good controls, such as steam baths, salt and sand baths, oil baths, heating mantles and hot air baths. Do *not* use open flames; along with being a potential ignition source, it is harder to maintain exact control of the heat applied. Go to Section 4 on heating equipment.

You should also minimize the total quantity of flammable materials in the lab and keep them stored in proper containers (plastic or metal containers, or safety cans) as described in Section 2.D.3 (above). Cap containers as soon as you have poured out the amount needed.

To prevent the spill and release of vapors while transporting bottles, use bottle carriers. Dispose of unnecessary flammable chemicals to prevent inadvertent spills.

Be aware that the vapors of many flammable liquids are heavier than air, can travel considerable distances along a benchtop or the floor and can potentially be ignited by a source located in the lab or workspace. These vapors can be generated by a spill or during a simple transfer from one container to another.

**b. Ignition Source Control**

Control all ignition sources in areas where flammable liquids are used. Open flames and spark- producing equipment should not be used.

Use equipment with spark-free, intrinsically safe induction motors or air motors to avoid producing sparks. These motors must meet National Electric Safety Code (NFPA 70) Class 1, Division 2, Group C-D explosion resistance specifications. Many stirrers, Variacs, outlet strips, ovens, heat tape, hot plates, and heat guns do not conform to these code requirements.

Avoid using equipment with series-wound motors, since they are likely to produce sparks.

Equipment On/Off switches can produce sparks when activated, especially if the equipment uses a lot of power. Place equipment switches as far as possible from any open systems using flammable liquids.

**c. Grounding Concerns**

Pouring flammable liquids can generate static electricity. The development of static electricity is related to the humidity levels in the area. Cold, dry atmospheres are more likely to facilitate static electricity. Bonding or using grounding straps for metallic or non-metallic containers can prevent static generation. All metal containers larger than one gallon (4 liters) must be grounded to avoid static charge when transferring flammable liquids to another container. Grounding can be direct, (e.g., a wire attached to both containers) or indirect (e.g., wires connected to a common ground system). When grounding non-metallic containers, contact must be made directly to the liquid rather than to the container.

In the rare circumstance that static electricity cannot be avoided, and grounding is not possible, such as pouring small volumes of flammable liquids into a graduated cylinder or beaker, proceed slowly to give any static charge time to disperse. Alternatively, conduct the procedure in an inert atmosphere.

For more information regarding bonding and grounding can be found in the EH&S Grounding and Bonding focus sheet.

## 11. Homeland Security Chemicals of Interest

Regulations, Title 6 Code of Federal Regulations Part 27, required all chemical facilities (including universities) to comply with the Chemical Facility Anti-Terrorism Standards (CFATS) The rule required that a chemical facility that either possessed or later came into possession of listed chemicals in quantities that met or exceeded threshold quantities, report them to DHS. Under this regulation, a University building was deemed

a chemical facility and EH&S was charged with reporting building overages to DHS. The federal CFATS act expired in July 28, 2023 and therefore there are no requirements for laboratories at this time.

### 12. Process Safety for Highly Hazardous Chemicals

If there is any chance that the quantities of hazardous chemicals handled at one time may exceed the quantity limits of WAC 296-67, *Process Safety Management of Highly Hazardous Chemicals*, additional safety precautions must be taken. A table listing chemical limits in pounds that require implementation of this process is in Appendix A, WAC 296-67-285.

Among the requirements is a formal, documented failure analysis using techniques such as:

- What If analysis Checklist.
- Fault Tree Analysis.
- Hazard and Operability Study (HAZOP).
- Failure Mode and Effects Analysis (FMEA).
- Other equivalent methodology for assessing hazards.

Assistance on these techniques is available from EH&S at 206.543.7388. Other requirements, such as storing highly toxic gases in a gas storage cabinet, may be required as described earlier in this section.

### 13. Chemotherapy and Hazardous Drugs

Drugs are classified as hazardous if they may cause cancer, developmental or reproductive toxicity or harm to organs at low doses. They include drugs used for cancer chemotherapy (also called antineoplastics), antiviral drugs, hormones, some bioengineered drugs, and other various drugs. To determine if a drug is classified as hazardous check the NIOSH List of Antineoplastic and Other Hazardous Drugs in Healthcare Settings (2014).

Follow safety precautions when working with hazardous drugs. These include use of exhausted enclosures, procedures to avoid personal exposure and contaminating surfaces, PPE and training of personnel in hazard awareness and safe work practices. Federal and state regulations and guidelines exist for the use, handling, storage, treatment and disposal of hazardous drugs in clinical and research settings. EH&S has developed guidance that includes procedures for safety, compliance and best practices. For research involving hazardous drugs at UW, follow UW guidelines.
More information on use and handling of chemotherapy and hazardous drugs can be found on the EH&S website.

## H. REGULATED HAZARDOUS CHEMICALS LISTED UNDER THE WAC WASHINGTON VERTICAL STANDARD

A number of chemicals are listed in the WAC as “regulated hazardous chemicals”; Table 2-5. There are additional requirements for these chemicals; if your research creates exposure potential for one or more of these chemicals, reach out to EH&S for help in achieving compliance with the specific standard.

Additional information is available onn the Specific Chemical Hazards and Asbestos and Other Regulated Building Materials webpages.

***Table 2-5 Regulated Hazardous Chemicals Listed in the WAC***

## Regulated Hazardous Chemicals Listed in the WAC

Acrylonitrile
Benzene
Coke ovens,
Ethylene oxide
Methylene chloride (aka Dichloromethane)
Ionizing radiation
4,4'Methylene bis (2 - chloroaniline)
Bis-Chloromethyl ether
Beta-Naphthylamine
Beta-Propiolactone
Arsenic (inorganic)
Butadiene
Cotton dust
Formaldehyde
Vinyl chloride
4-NitrobiphenylAlpha-Naphthylamine
Methyl chloromethyl ether
Benzidine
2-Acetylaminofluorene
4Dimethylaminoazobenzene
Asbestos
Cadmium
2-Dibromo-3- chloropropane
Lead
Methylenedianiline
3,3'-Dichlorobenzidine (and its salts)
Acrylonitrile
4-Aminodiphenyl
Ethyleneimine
N-Nitrosodimethylamine

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# SECTION 3: CHEMICAL WASTE MANAGEMENT

***Contents***

## A. HAZARDOUS CHEMICAL WASTE RESPONSIBILITIES

Hazardous chemical waste must be managed properly. The responsibilities of the laboratory worker and of EH&S for hazardous waste are as follows:

### 1. Laboratory Workers

If laboratory workers generate chemical waste, they must be able to determine whether their chemical wastes are hazardous by using the guidelines in this chapter or by filling out a Waste Evaluation Request. For hazardous waste, they must identify the hazards of the waste and follow accumulation rules, which include labeling, storage, and handling requirements. They must know how to request collection of hazardous waste by EH&S, as well as the rules for disposal of chemicals and contaminated items to trash and sanitary sewer. They must prevent the accumulation of legacy chemicals and inherently waste-like chemicals (defined in this section) by cleaning out their chemical inventory on a regular basis.
Training is required and is available through EH&S in both classroom and online format.

### 2. UW EH&S Environmental Programs

EH&S Environmental Programs (EP) collects hazardous waste and manages its proper disposal. EH&S provides guidance and training for laboratory workers on proper hazardous waste management.

## B. WHAT QUALIFIES AS HAZARDOUS WASTE?

A chemical or chemical mixture that exhibits any corrosive, flammable, toxic, reactive and/or persistent in the environment properties is, by legal definition, hazardous. At the UW, some additional chemicals are managed as hazardous waste because they are carcinogenic.
To determine if your chemical is hazardous, use your knowledge, the chemical's original label and/or the chemical's SDS to determine if the waste is corrosive, flammable, toxic, reactive, persistent in the environment and/or mutagenic or carcinogenic, as defined in the below sub-sections. For additional reference, MyChem inventory lists indicate which chemicals are considered hazardous.

### 1. Flammable/Ignitable

A waste chemical is flammable if it is one of the following:

- A liquid with a flash point less than 140 °F (e.g., ethanol, xylene, or diethyl ether). The flash point is defined as "the lowest temperature at which a chemical can form an ignitable mixture with air" (by evaporating above an open beaker, for example.) The SDS typically includes information about the flash point if the chemical has one. (Note: the hazardous waste designation of "Flammable" includes not only those classified as flammable per NFPA as described in Section 2.D.3, but also those classified as "Class II Combustible.")
- A solid or gas capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture, or spontaneous chemical changes which burns so vigorously and persistently that it creates a hazard.
- A solid, liquid, or gas that evolves oxygen at room temperature or under slight heating (e.g., peroxides, chlorates, perchlorates, nitrates, and permanganates.)

### 2. Corrosive

A waste chemical is corrosive if it has a pH of less than 2 or greater than 12.5.

### 3. Reactive

A waste chemical is reactive if it is one of the following:

- A normally unstable compound that readily undergoes violent change (*e.g.,* acrylonitrile, butyl hydroperoxide).
- When mixed with water, the chemical reacts violently, forms potentially explosive mixtures, or generates toxic gases in sufficient quantities to present a danger to human health (e.g., sodium metal, chloropropionyl chloride).
- The compound contains cyanides or sulfides that, when exposed to pH conditions between 2 and 12.5, could generate toxic gases in sufficient quantities to endanger human health (*e.g.*, sodium sulfide, arsenic sulfide).

### 4. Toxic

#### a. Toxicity Categories

Toxicity is based upon the $LC_{50}$ (concentration of substance required to kill 50% of the tested population) for fish or the $LD_{50}$ (dose amount of substance required to kill 50% of the tested population) for rats. This information is usually listed on a chemical's SDS.

Table 3-1 lists five categories of toxicity: X, A, B, C, and D; the X category (Tox-X) is the most toxic. If data is available for more than one toxicity test, use the data showing the severest toxicity.

***Table 3-1 Chemical Waste Toxicity Categories***

| Toxic Category | Fish $LC_{50}$ (ppm) | Oral (rat) $LD_{50}$ (mg/Kg) | Inhalation (rat) $LC_{50}$(mg/L) | Dermal (rabbit) $LD_{50}$ (mg/Kg) |
|---|---|---|---|---|
| X | <0.01 | <0.5 | <0.02 | <2 |
| A | 0.01- <0.1 | 0.5 - <5 | 0.02 - <0.2 | 2 - <20 |
| B | 0.1- < 1.0 | 5 - <50 | 0.2 - <2 | 20 - <200 |
| C | 1.0- <10.0 | 50 - <500 | 2 - <20 | 200 - <2,000 |
| D | 10.0 - 100.0 | 500 - 5,000 | 20 - 200 | 2,000 - 20,000 |

Chemical waste that qualifies for any of these categories is hazardous waste. Chemical waste that qualifies for toxic categories X, A, or B is extremely hazardous waste and is subject to additional requirements, such as a maximum waste accumulation volume of one quart (refer to the below). Chemical waste with toxicity below the D category is not regulated as toxic but may still be managed as hazardous waste if it is carcinogenic/mutagenic.

For mixtures, such as diluted wastes and wastes containing more than one constituent, an Equivalent Concentration (EC) for the mixture must be calculated to determine the toxicity level of the mixture. If the EC is greater than or equal to 0.001%, the waste is toxic. The formula for the EC is:

$$EC(\%) = \Sigma X\% + \frac{\Sigma A\%}{10} + \frac{\Sigma B\%}{100} + \frac{\Sigma C\%}{1{,}000} + \frac{\Sigma D\%}{10{,}000}$$

For example, a mixture of 0.01% aldrin (toxic category A), 1.0% endrin (toxic category A), 4.0% benzene (toxic category D), 2.0% phenol (toxic category C) and 5% dinoseb (toxic category B) in water (nontoxic) exceeds the toxicity:

$$EC(\%) = 0\% + \frac{(1.0\% + 0.01\%)}{10} + \frac{5.0\%}{100} + \frac{2.0\%}{1{,}000} + \frac{4.0\%}{10{,}000} = 0.153\%$$

If you are not confident enough or willing to use the above equation to determine whether your chemical mixture is toxic, please fill out and submit a Waste Evaluation Request. EH&S staff will then evaluate your waste and advise you on proper disposal of your chemical(s).

**b. EPA P-Listed Hazardous Waste**

EPA P-listed chemicals have especially acute toxicity hazards and, because of this, more stringent requirements when disposed of as hazardous waste. Refer to Washington Administrative Code (WAC) 173-303 for specific information, such as the P-listed chemicals. Contact EH&S at 206.616.5835 for updated information.

A waste is regulated under the EPA P-list if the chemical waste is unused (including prepared solutions) and the listed chemical is the sole active ingredient of the product. Active ingredients are those that perform the function of the product, regardless of the concentration of those ingredients. Ingredients used as preservatives, solvents, stabilizers, and adjuncts are not active ingredients unless that is the function of the product. Examples of the criteria in practice are as follows:

- Sodium azide is the sole active ingredient in some broad-spectrum pesticides; these pesticides would be P-listed acute hazardous wastes if disposed of unused.
- Some automotive airbag activators contain ferric oxide as an oxidizer, in addition to sodium azide as a propellant - both are active ingredients. These activators would not be P-listed wastes when disposed of because the sodium azide was not the sole active ingredient.
- Some pregnancy test strips contain sodium azide as a preservative. These strips would not be P-listed wastes when disposed of because sodium azide is not an active ingredient.

Requirements for P-listed wastes include:

- Container size: When collecting P-listed chemicals as waste, the volume of the hazardous waste container must not exceed one quart(approximately one liter).
- Empty containers: Empty containers that held P-listed chemicals must also be disposed of as hazardous waste; they are not allowed to be washed or re-used.
- Contaminated materials: Disposable materials that become contaminated with P- listed chemicals (e.g., gloves, weighing boats, etc.) must be disposed of as hazardous waste; non-disposable materials must be triple-rinsed, or rinsed three times to remove the contamination - this rinsate must be collected as hazardous waste. Materials contaminated with P-listed chemicals may not be washed or re- used until they have been triple- rinsed.

Refer to the Federal listing of EPA P-listed chemicals.

Persistent chemicals do not biodegrade quickly in the environment. There are two main categories of

persistent chemicals, described below:

#### c. Halogenated Organic Compounds

A halogenated organic compound (HOC) is a molecule that includes one or more atoms of fluorine, chlorine, bromine, or iodine. When a waste mixture contains one or more halogenated organic compounds, the total halogenated organic compound concentration is determined by summing the concentration percentages of each halogenated organic compound. If a waste mixture contains more than 0.01% HOC, the waste is persistent and therefore hazardous. For example, a waste contains 0.009% carbon tetrachloride, 0.012% DDT, and 0.020% 1,1,1-trichloroethylene. The total halogenated organic compounds concentration calculation indicates the mixture is persistent, as follows: Total HOC Concentration = 0.009% + 0.012% + 0.020% = 0.041%.

#### d. Polycyclic Aromatic Hydrocarbons

The following polycyclic aromatic hydrocarbons (PAHs) are regulated: acenapthylene, acenapthene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(q,h,i)perylene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, fluoranthene, fluorine, naphthalene, phenanthrene and pyrene. When a waste contains one or more of these PAHs, determine the total concentration by summing the concentration percentages of each regulated polycyclic aromatic hydrocarbons. If the waste contains more than 1% PAHs, the waste is persistent and therefore hazardous. For example, a waste contains 0.08% chrysene and 1.22% 3,4-benzo[a]pyrene. The total polycyclic aromatic hydrocarbon concentration calculation demonstrates the mixture is persistent as follows: Total PAH Concentration = 0.08% + 1.22% = 1.30%.

### 5. Carcinogenic

The Washington Department of Ecology briefly regulated chemical wastes that are suspected or known to be carcinogenic. However, these rules were challenged and the Department of Ecology retracted the rules. Nevertheless, EH&S strongly encourages you to manage chemical waste that is carcinogenic or mutagenic as if it were hazardous waste, even if it is not toxic according to the definition above, which accounts for acute and immediate toxicity. An example of chemical waste management/disposal of carcinogens/reproductive hazards is at the EH&S web page Chemotherapy and Other Hazardous Drugs.

### 6. Waste Evaluation Request

If you are unsure whether your waste is hazardous, please submit a Waste Evaluation request. Fill out all information completely and attach the SDS(s) for the chemical(s). EH&S staff will evaluate your waste stream and advise you on proper disposal.

## C. HAZARDOUS WASTE ACCUMULATION RULES

University personnel who generate hazardous chemical waste at the University (including all campuses and off-site locations) are required to follow chemical waste management practices as outlined in below:

### 1. Appropriate Containers

All waste must be stored at the point of generation. You may not generate your waste in one room and move it to another. In a large, shared space it would be acceptable to have one location for waste storage.

Accumulate waste in an appropriate container compatible with the waste.

You may reuse containers, even containers that were used for other chemicals, if they are

compatible, have been rinsed and the original labels have been defaced (note that the rinseate may be hazardous waste according to the definitions in Section 3.B, above.) Do not place chemicals in household product containers, such as food containers. The Empty Chemical Containers Focus Sheet provides guidance to dispose of or reuse chemical containers in accordance with hazardous waste regulations.

Containers designed for solid chemicals should not be used for liquids. It is not recommended to use containers that previously contained a chemical that is incompatible with the chemical contents of the waste. Use only containers that show no sign of damage or deterioration.

You must use containers with screw top closures. Waste containers must remain closed, except when you are adding waste. Use spring-loaded funnels for adding waste frequently to waste containers.

Syringes, vials, or small items containing chemicals should be placed in secondary containment for collection.

Finally, do not fill the containers completely. Each container should not be more than ¾ full to allow for pressure changes due to changes in temperature. Request collection of your waste ahead of time to avoid overfilling your containers.

### 2. Hazardous Waste Labels

Label the container using the Hazardous Waste Label found on the EH&S website (Figure 3-1).

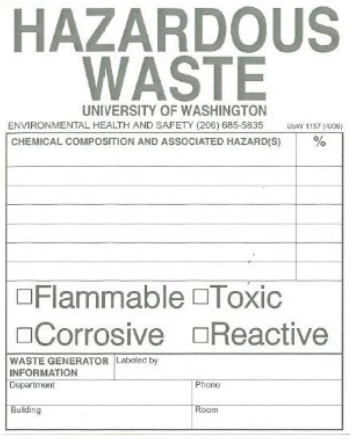
HAZARDOUS WASTE
UNIVERSITY OF WASHINGTON
ENVIRONMENTAL HEALTH AND SAFETY (206) 685-5835
CHEMICAL COMPOSITION AND ASSOCIATED HAZARD(S) %
☐Flammable ☐Toxic
☐Corrosive ☐Reactive
WASTE GENERATOR INFORMATION Labeled by
Department Phone
Building Room

*Figure 3-1 Hazardous Waste Label*

Fill out the pdf label completely, including percentages of constituents, the hazards of the waste, and contact name. If you do not know the hazards of your chemical, use the SDS of the chemical to determine what they are. Do not date the container or label. Deface or remove any original labels remaining on the container to avoid confusion about the identity of the waste.

Hazardous waste labels are available online.

Waste must be under the control of the individual(s) generating the waste. The waste should be in a physically safe area (*e.g.*, not on a windowsill.) Waste chemicals may be stored with unused chemicals as long as the containers are properly labeled, and your laboratory personnel know the storage location.

- Do not accumulate large amounts of waste in the fume hood. Use flammable storage cabinets for flammable waste over ten gallons in volume.
- Store waste away from emergency equipment, such as safety showers and emergency access panels; do not block exits.

- Do not store the waste under, above, near or in sinks. If the waste is stored inan area that drains to a floor drain, the waste must be in secondary containment.

### 3. Segregation

Segregate regulated chemical waste by chemical compatibility. Refer to the segregation guidelines in Section 2 of this manual. Use secondary containment (tubs, basins, or buckets) for segregation of incompatible wastes accumulated in the same area.

### 4. Accumulation Limits

Accumulate no more than 200 liters (55 gallons) of chemical waste per waste stream or one liter (one quart) of extremely hazardous waste per waste stream. Extremely hazardous waste is waste that is highly toxic, and the one-liter limit is designed to limit risk, especially in the event of a spill. Refer to the Safety Data Sheets webpage for how to determine whether your waste is extremely hazardous waste.

Chemical waste must not be stored for more than one year.Leave some head space (at least one inch) in each container to allow for pressure changes due to changes in temperature.

Any type of flammable chemical (including waste) cannot exceed the control area limits specified by the local fire department. For example, in Seattle, for class IA flammables (which include ethers and other very flammable solvents) the total volume of allowed flammables is limited to 60 gallons per control area in a sprinkler building, and 30 gallons in a non-sprinkler building.

Contact EH&S at 206.685.0341 with questions about control areas and volume limits if you accumulate large amounts of flammable hazardous waste.

### 5. Large Containers (Drums)

If you are accumulating waste in containers greater than five gallons in volume, make sure the drums are in good condition, and are approved by the Department of Transportation (DOT) for highway-mode transportation. If the drums were initially shipped to you, they are likely DOT-approved.

Drums containing liquids must have ten centimeters of air space between the liquid surface and the lid. Collection must be requested before the drum is full, especially in the case of 55- gallon drums.

### 6. Inherently Waste-like Chemicals

Inherently waste-like chemicals include expired chemicals, chemicals in deteriorating containers, and chemicals that appear to be, or are, unusable. State inspectors may issue fines or infractions for inherently waste-like chemicals in your laboratory. Do not keep chemicals past their expiration date and conduct cleanouts when doing your annual chemical inventory update. Please also Refer to the section on legacy chemicals in Section 3.G.3 (below).

## D. HAZARDOUS WASTE COLLECTION REQUESTS

### 1. Hazardous Waste Collection Overview

EH&S collects hazardous chemical waste from all UW campuses and UW-owned and -operated facilities. This service is covered by overhead on research grants. Properly labeled and identified chemical waste is collected free of charge, with certain exceptions. There are about 4,000 laboratories on and near the Seattle campus. Therefore, EH&S may only be near your area once every week or every other week. Approximate collection time is two-to-four weeks at UW Seattle and on a set schedule at other locations. To avoid problems, plan ahead and request collection before your containers are full.

### 2. Collection Requests – One-Time

Request collection of your waste in one of two ways:

- Submit a Chemical Waste Collection Request online.
- Submit a collection request from your MyChem inventory.

### 3. Routine Collection Requests

Waste generated on a regular basis may be set up as routine collections. For routine collections, EH&S assigns your chemical waste a routine number. To request pickup, enter your routine number and waste volume in an online form. EH&S tracks what your waste is and where you are located. If you have a routine waste number and want to request a pickup, fill out and send the Routine Chemical Waste Collection Request. If you have any questions about whether your waste is routine, email chmwaste@uw.edu or call 206.616.5835.

### 4. Waste Cleanouts

If you are moving or cleaning out your workplace and will need EH&S to collect a large volume of chemical waste, here are some guidelines:

- If you think you have more than 100 containers of waste, call 206.616.0595 to arrange a cleanout appointment at least one month before your deadline.
- For fewer than 100 containers, fill out and submit the Chemical Waste Collection Request.
- Place completed UW Hazardous Waste Labels on each waste container (not needed for containers with an original label and original contents). Refer to Section 3.C.2.
- Consider the MyChem Chemical Exchange for your unwanted but useable chemicals (useable chemicals are unexpired and preferably unopened).
- Remember to update your chemical inventory in MyChem

### 5. What Happens to Hazardous Waste?

EH&S has a Waste Minimization Program that reuses, recycles, and treats more than 50% of the total waste generated at the UW. Reuse, recycling, and treatment takes place both in laboratories and at the EH&S hazardous waste facility. Some waste streams, like batteries, paint and oil are sent offsite for recycling by contractors. For more information, refer to the subsection below and visit the EH&S website.

All hazardous waste at the UW that is not reused, recycled, or treated is sent to permitted hazardous waste recycling and disposal facilities. Flammable waste is used as an alternative fuel to incinerate hazardous waste. Most of the other waste streams are incinerated at a high temperature. A few waste streams are placed in permitted hazardous waste landfills.

## E.TRASH DISPOSAL

Non-hazardous solid chemicals can go in the trash. Irritants, sensitizers and known, probable, or suspected carcinogens *cannot* go in the trash. Deface labels, bag, and label non-toxic chemicals as "non-hazardous." Liquids and pressurized containers, like non-empty aerosol cans, can never go in the trash. Uncontaminated and slightly contaminated items such as gloves, paper towels and empty containers can go in the trash. EH&S recommends double bagging and labeling these items as non-hazardous if there is evidence of contamination. Manage very contaminated items, such as spill cleanup materials, as hazardous waste. In addition, empty containers for extremely toxic chemical are hazardous waste unless you triple rinse them and dispose of the rinsate as hazardous waste. Always dispose of P-listed empty chemical containers as hazardous waste.

### 1. Trash Disposal of Chemicals

The following are prohibited in the trash because of their chemical or physical hazards:

- Hazardous chemical waste as defined earlier in this section.
- Known, probable or suspected carcinogens, irritants, and sensitizers (*Refer to current SDS to determine if chemical is any of these).
- Free liquids of any type.
- Pressurized vessels (including non-empty aerosol cans).
- Laboratory glass and sharps.
- Radioactive waste.
- Batteries.
- Mercury (including thermometers).
- Biohazardous waste.

To throw away chemicals that are not prohibited in the trash, make sure to deface any labels, securely double bag it, and label it “non-hazardous” so that custodial staff know it is safe for them to handle the trash.

### 2. Trash Disposal of Empty Chemical Containers

Empty chemical containers may still contain enough chemicals in them to present a hazard to custodial staff. On the other hand, it can be difficult to completely empty a container. The legal interpretation of the word "empty" acknowledges this difficulty. A container is legally empty when both of the following are true:

- Contents have been removed by normal, such as inverting and draining, shaking, scraping, or scooping.
- No more than three percent of the contents remain.

If the chemical is extremely hazardous waste or a pesticide marked with danger or warning labels, then the container must be triple rinsed before it is legally empty. The rinseate from this process is also considered hazardous waste by law. For the definition of extremely hazardous wastes, refer to Appendix B. If your chemical is a known or suspected carcinogen, EH&S strongly recommends that you triple rinse the container.

**Exceptions**: Dispose of P-listed empty chemical containers as hazardous waste. Dispose of chemotherapy/hazardous drug empty chemical containers as trace chemotherapy waste.

It is **illegal to dispose of hazardous waste** by leaving non-empty containers of chemicals in the fume hood, or elsewhere, to evaporate the chemical.

If you choose to dispose of the empty container, do the following:

1. Dry the empty container, preferably in a fume hood; ensure that there are no sources of heat or open flame in the fume hood when drying containers that contained flammable chemicals.
2. With a pen or marker, cross out the labels on the container.
3. Leave the container uncapped; throw the cap away separately.
4. If the container fits, place it in the trash can; if it does not fit, place it next to the trash.
5. Do not leave empty containers in public areas (such as hallways or loading docks)

unless you have made an agreement with Custodial Services or EH&S for pickup services.

Consider reusing the empty container for accumulation of waste for that same chemical or other compatible chemicals. If you reuse a container, deface or remove the label on the container and then fill out and affix a hazardous waste label to the container. Defacing and labeling are required by law and help others in your workplace know that the container contains hazardous waste and not the original chemical. Refer to the empty container recycling guidelines on the EH&S website.

Do not recycle glass or plastic containers that contained chemicals unless approved by EH&S. (Recycled glass and plastic are used for beverage and food containers, so the recycling industry cannot accept any that held chemicals).

### 3.Trash Disposal of Contaminated Items

Used gloves and other commonly used items (besides empty containers) can be placed in the trash if they are not grossly contaminated with hazardous chemicals. If you have an item that is grossly contaminated, dispose of it as hazardous chemical waste.

Examples of grossly contaminated items include used spill clean-up materials, items such as gloves and equipment contaminated from a spill, and used equipment that contains hazardous chemical residue.

EH&S encourages you to collect items that look like they might be contaminated by chemicals, such as weighing papers and gloves, in bags and then label the bags "non-hazardous waste" before you place them in the trash. Custodial staff members are sometimes understandably nervous when handling laboratory trash; a white residue or a few drops of water in the trash could be a dangerous chemical. Taking an extra step to bag these items can be a nice gesture.

Custodians may refuse to collect trash that appears to contain hazardous items. If they refuse to collect trash, they will leave a Notice of Improper Waste Disposal Practices form (UoW 1970). Once corrections are made, they will collect the trash.

**Exceptions:** Dispose of P-listed chemically contaminated items as hazardous waste. Dispose of chemotherapy/hazardous drug contaminate items as hazardous waste.

## F. DISCHARGES TO THE SANITARY SEWER

Please complete and submit the Waste Evaluation Request to see if a specific chemical or waste stream is appropriate to sink discharge. If not, that same form can be used to complete a waste determination and determine disposal options.

King County Industrial Waste establishes rules that determine what can be poured down the sink. These are sometimes more stringent than Hazardous Waste rules. Please also refer to current permits or rules established by King County.

All liquid waste discharged to the sanitary sewer system must be approved under the current UW permit and local Sewer Discharge Limits. These are designed to protect surface waters, utility workers, and maintain the quality of bio-solids from wastewater treatment plants.

### 1. King County Local Sewer Discharge Limits

Certain non-hazardous waste liquids can be discharged to the sanitary sewer. All discharges to the sanitary sewer need to meet site-specific limits and general conditions detailed in the current permit. If chemically treated before discharge, records of this disposal must be kept as described in Section 3F.3 (below). Waste that qualifies as hazardous (according to the criteria in Section 3.B above) may not be sewer discharged. King County has published local discharge limits for commonly

used chemicals. These limits are on the King County website. They apply only to UW Seattle, UW Bothell, and other sites within King County.

### 2. Outside King County

If you are outside King County (e.g., Tacoma, Pack Forest, and Friday Harbor), local sewer limits have not been formally approved or permitted. Operators of some very small waste treatment plants allow chemical disposal only on a case-by-case basis to protect the treatment plant. You are therefore not allowed to pour any chemicals down the drain without explicit permission at this time.

For more information and for assistance with obtaining permission to dispose of non-hazardous chemicals to sanitary sewer, call EH&S at 206.685.3759 or email chmwaste@uw.edu.

### 3. Treating Hazardous Wastes

Notify EH&S at 206.616.5835 or chmwaste@uw.edu before treating hazardous waste. Please review the EH&S website for example treatment methods.

You must keep a log of all hazardous wastes you have treated and provide it to EH&S upon request. An example chemical treatment log is online.

### 4. Soaps, Bleach and Acetone

When washing glassware or equipment, you will likely use chemicals such as detergents and standard household bleach, which may go down the sink drain. This is acceptable.

Acetone may *not* go down the sink drain at any concentration. If you use acetone to rinse off items, you must collect any excess acetone in a securely capped, properly labeled waste container and dispose of it as hazardous waste (refer to the hazardous chemical waste page for more information.) You may not store acetone squeeze bottles near the sink.

Do not use chromate-based cleansers. There are many less toxic and non-carcinogenic alternative cleansers that work just as well.

### 5. Scintillation Fluids

There are only three liquid scintillation cocktail products currently approved by the State of Washington Department of Ecology for disposal down the sanitary sewer. Refer to the Liquid Scintillation Focus Sheet for more information. They are soluble (or readily dispersible) in water and contain less than 10% non-ionic surfactants. Other scintillation fluids may claim to be safer, but because they contain high concentrations of flammable surfactants, they are not approved for sewer disposal.

### 6. Dilution Prohibition

It is illegal to dilute your chemical waste solely to meet sewer discharge limits. However, you may sewer waste such as equipment rinse water or any chemical treatment that you do as a normal part of cleaning up after an experiment, if it meets sewer discharge limits.

## G. CHEMICAL WASTES OF PARTICULAR CONCERN

### 1. Unknown Chemicals

Without an accurate chemical name and concentration range, unknown or unidentified chemicals cannot be safely handled or disposed of. The best way to prevent unknowns is to label all chemical containers and make sure that the labels stay in good condition over time. If you have an unknown chemical, keep it where it is or store it temporarily in the fume hood, whichever you believe to be safer. Find out as much information as you can about the chemical by examining the container and interviewing anyone you think might know something about it. If that fails, complete an online Chemical Waste Collection Request. Provide as much information about the waste as possible, such as the history, physical properties and the results of any analysis performed on the unknown. If you have any questions or concerns regarding the disposal of an unknown chemical, email chmwaste@uw.edu or call 206.616.5835.

Identification analysis performed by the approved waste disposal contractor will cost the chemical user approximately $80 per unknown chemical.

### 2. Potentially Explosive Wastes

Some common chemicals can become highly unstable explosives over time when stored improperly and cannot be collected as hazardous waste unless they have been deactivated and stabilized. The following segments highlight the most common of these troublesome chemicals.

#### a. Peroxide-Forming Chemicals

Peroxide-forming chemicals that have exceeded the manufacturer's expiration date, such as p-dioxane, diethyl ether, tetrahydrofuran and acetaldehyde, will not be collected for disposal until they have been tested for peroxides. These chemicals must be managed correctly. For more information, refer to section 2.G.2.b and the EH&S Peroxide Forming Chemicals Management and Assessment Guidelines.

Chemicals containing more than 10 parts per million (ppm) peroxides must be deactivated before they will be collected by EH&S. Treatment methods are available through EH&S; call 206.616.5835 or email chmwaste@uw.edu to obtain more information.

#### b. Picric Acid and Other Polynitroaromatic Compounds

Polynitroaromatic compounds are commonly used in laboratories and are safe in the form in which they are sold. They are ordinarily sold with three to 10% water added to stabilize them. However, they will become explosive if allowed to dry out. Dry polynitroaromatic compounds must be wet with 10% water before they can be collected by EH&S.

#### c. Sodium Azide

Sodium azide, although not inherently unstable, can form highly explosive heavy metal azides if contaminated or used improperly. Do not pour sodium azide into the sanitary sewer. Sodium azide is classified as highly toxic, and disposal of sodium azide solutions to the sewer can cause the formation of lead or copper azides in plumbing. Routine sewer disposal of sodium azide has caused several serious explosions.

#### d. Nitrocellulose

Several nitrocellulose products, primarily paper and tubes, are used in some laboratories. Nitrocellulose burns vigorously in ambient conditions and may explode when heated under confinement. When completely dehydrated, it is considered a low-level explosive. As a result, these products should never be autoclaved for decontamination.

Nitrocellulose products must be soaked in water before disposal through EH&S.

### 3. Legacy Chemicals

Responsible Party's are required to completely clean out laboratories before they leave, including all hazardous chemicals and waste (refer to Section 10, Moving In/Moving Out.) However, sometimes people leave without disposing of chemicals properly. Legacy chemicals are those that are left behind by laboratory personnel when they leave the University or move laboratories. They become the responsibility of the new space occupants. If you move into a laboratory that has legacy chemicals in it, you must tell your department administrator immediately. If your department, for whatever reason, cannot solve the problem, then these legacy chemicals are yours to manage. Unless you think that you will use them, arrange to request their collection as hazardous waste, and follow all waste accumulation rules, including hazard identification, labeling and segregation.

## H. HAZARDOUS WASTE MINIMIZATION

On average, EH&S collects, and processes about 200,000 kg of hazardous chemical waste a year. EH&S has developed several programs to reduce the amount of hazardous waste that must be incinerated or landfilled. For the last several years, the UW reused, recycled, or treated about 40% of our hazardous chemical waste. This section outlines some of the basic elements of this effort and how you can participate.

For an extensive and detailed list of hazardous waste services and resources, visit the EH&S website.

Purchase only what you think you will use, especially if you're purchasing a hazardous chemical.

Shop for free chemicals in the MyChem Chemical Exchange. For more information, visit the EH&S website at www.ehs.washington.edu/chemical/chemical-exchange.

### 1. Treatment and Recycling in the Laboratory

You are encouraged to treat or recycle your own waste. EH&S staff are available to help you get started, and in some cases, offer free materials for recycling and treatment. Refer to the Chemical Treatment & Recycling webpage for details.

### 2. Hazardous Materials Recycling

Both EH&S and UW Recycling manage the recycling of materials that would otherwise be disposed of as hazardous waste. Visit the Chemical Treatment & Recycling webpage for all the common (and sometimes uncommon) items -- from batteries to computer monitors to elemental mercury to scrap metal.

## I. SOLID WASTE AND RECYCLING

Guidelines for recycling common non-chemical items in laboratories:

### 1. Paper and Cardboard

EH&S encourages you to recycle boxes and packaging as soon as possible unless you have sufficient storage space. Storing boxes in aisles, in front of emergency equipment or exits, or necessary fire panels is illegal and dangerous. Paper, cardboard, and other common recyclables are managed by UW Recycling. For more information, refer to the at:

### 2. Plastic and Glass

Plastic and glass chemical containers are not recyclable currently. The glass and plastic recycling industry uses recycled material to make food and beverage containers and bans chemical containers, even if rinsed clean, from their recycling streams.

Laboratory glass and plastic waste are not technically sharps but can puncture regular waste bags and injure waste handlers. The rules for packaging and disposal of laboratory glass and plastic waste differ depending on whether or not the items are contaminated. For more information, visit the Sharps and Lab Glass Waste webpage on EH&S's website.

UW Recycling encourages customers to purchase and recycle pipette tip boxes and trays through a vendor with its own recycling program. A list of these vendors can be found on the pipette tip boxes and trays website page. If you are unable to recycle your pipette tip boxes and trays through the manufacturer, please dispose of your pipette tip boxes as mixed recycling and pipette tip trays as garbage.

### 3. Packaging Materials

UW Recycling also coordinates the recycling of special material like wooden pallets, packaging peanuts, plastic wrapfilm, and other packaging materials. Styrofoam on the Seattle Campus. For more information, visit the UW Recycling disposal guide.

### 4. Printer Cartridges

UW Recycling collects printer/copier cartridges and fuser drums for our contracted vendor to recycle or reuse. Please see UW Recycling's disposal guide on printer cartridges for more information.

Waste toner cartridges must be disposed of as landfill. Any new or unused items should be sent to UW Surplus.

### 5. Batteries

The UW recycles all types of batteries. Batteries cannot be placed in the trash because they contain corrosive acids and toxic metals. The UW and other institutions and businesses are also required to recycle alkaline batteries, even though households can place them in the trash. Please reference UW Recycling's disposal guide on batteries for specific information.

Battery collection is a joint effort by UW Recycling and EH&S EP. Small amounts of batteries (less than 5lbs) can be recycled through the eMedia system. Disposal of collections of batteries over 5 lbs. and large batteries, including those from research, heavy equipment and laptops, are handled two ways:

#### a. One-Time Battery Collection

To request a special collection of more than five pounds of batteries, fill out an online Chemical Waste Collection Request, listing them as "Batteries, mixed."

#### b. Routine Battery Collection

If you have a routine number, request a pickup with the online Routine Chemical Collection Request.

### 6. Metallic Lead

UW Recycling and EH&S have specific instructions for recycling metals and metallic lead. Lead should be kept separate from all other types of metals. Please see UW Recycling's Metal Disposal Guide for more information.

## J. SHARPS, LAB GLASS AND PLASTIC

The following are guidelines for the disposal of sharps and lab glass:

### 1. Sharps

Sharps are a regulated waste classification and must never be disposed of in the regular waste stream. The following are always sharps waste:

- Needles, including syringes with needles, and IV tubing with needles attached
- Lancets
- Scalpel blades

The following are sharps waste *only* if contaminated with biohazardous material (including recombinant or synthetic DNA/RNA):

- Broken glass
- Razor blades
- Fragile glass tubes, vials, or ampoules (including Pasteur pipettes)
- Glass slides and cover slips

Sharps must be disposed of in a red plastic sharps container which is leak proof, rigid and puncture-resistant. It must be labeled with a biohazard symbol and equipped with a tight-fitting lid for use during handling and transport. Various sizes of sharps containers are available from Biochemistry Stores and vendors. It is recommended to use several small containers that are accessible in the work area. Never use cardboard boxes for packaging sharps.

When the sharps container is no more than 2/3 full, close the lid and place autoclave tape over the lid and sides without blocking the vent holes. Label with PI name and room number/building. If a sharps container is punctured or has needles sticking out of it, the entire container must be placed inside a larger sharps container prior to treatment and disposal. Do not attempt to empty a sharps container that has been punctured.

All sharps containers must be decontaminated prior to disposal. Treatment and disposal options vary depending on your work location (e.g., Harborview, South Lake Union, Health Sciences, or other UW Seattle campus building locations). Refer to the Biohazardous Waste Flow Charts for site-specific information. Additional information can be found on the EH&S website for options to decontaminate and dispose of sharps containers. EH&S does not collect sharps containers. Check with your department to find out if a sharps disposal waste stream already exists. If you are unsure how to treat and dispose of your sharps waste, contact EH&S Biological Safety at ehsbio@uw.edu.

**Exception:** Sharps used with hazardous chemicals that are flammable, reactive, corrosive, or toxic are not safe to autoclave.

- For sharps contaminated with hazardous chemicals that are not classified as “extremely hazardous waste,” package in a red sharps container and use a waste contractor to collect for off-site treatment and disposal. More information about off-site sterilization is available in “Decontaminate Biohazardous Waste” on the EH&S Biohazardous Waste webpage. EH&S training and account set up is required.
- For sharps contaminated with chemicals that are classified as Extremely Hazardous Waste, place in a DOT-approved puncture-proof container, and submit a Chemical Waste Collection Request. List everything the sharps are contaminated with and say in the notes “in a non-red sharps container.”

### 2. Trace Chemo and Hazardous Drug Sharps

Sharps and empty containers used with chemotherapy (chemo) and other hazardous drugs must be disposed of as trace chemo sharps waste. "Trace" refers to empty containers or containers that have less than three percent of the original quantity of drug remaining, such as sharps, empty syringes, and vials. An empty container is one in which all contents have been removed by normal means such

as aspiration, pouring or flushing. To determine if a drug is classified as hazardous check the NIOSH List of Antineoplastic and Other Hazardous Drugs in Healthcare Settings (2014).

Place sharps contaminated with chemotherapy (chemo) or hazardous drugs in a yellow trace chemo sharps container with a biohazard symbol. Do not autoclave yellow trace chemo sharps containers. All trace chemo and hazardous drug waste generated at the UW is collected and shipped off-site for disposal by incineration at a regulated facility. EH&S training and account set up is required. More information is available on the Chemotherapy & Hazardous Drugs webpage.

### 3. Biohazardous Lab Glass and Plastic

Biohazardous glass and plastic items include those contaminated with biohazardous material (including recombinant or synthetic DNA/RNA) that could puncture a plastic bag, such as:

- Syringes without needles
- Micropipette tips
- Serological pipettes
- Test tubes
- Swabs/sticks
- Other contaminated items (that do not fall under the sharps definitions and could puncture a biohazard bag).

Biohazardous lab glass and plastic must be decontaminated prior to disposal. Package contaminated plastic or glass in a container that cannot be punctured and can be easily autoclaved, such as commercially available pipette boxes. Or package contaminated items in a sturdy cardboard box lined with a biohazard bag and labelled with the biohazard symbol, “Laboratory Glass,” and PI name and room number/building. Use the Packaging Sharps and Lab Glass Waste poster for guidance.

### 4. Lab Glass

Lab glass waste (including plastic items) is defined as items that could puncture regular waste bags and endanger waste handlers. It does not include items contaminated with biohazardous materials. This category *never* includes needles, lancets, scalpel blades or any other sharps.

Examples of lab glass include:

- Broken glassware
- Empty chemical containers (test tubes, pipettes and tips, and centrifuge tubes)
- Syringes without needles
- Pointed swabs and sticks
- Razor blades
- Fragile glass items (such as glass Pasteur pipettes, glass slides and cover slips).

Package such lab glass waste in a sturdy cardboard box lined with plastic. The box should never weigh more than 25 pounds. When setting up a box for lab glass waste, clearly identify the PI name and room number/building. Seal the box with pre-printed lab glass tape or create your own tape using clear packaging tape over writing indicating “lab glass.” Lab glass boxes and tape can be purchased from the Chemistry stockroom or from vendors. Tape can also be purchased from Biochemistry stores. Place the sealed box alongside the regular waste container for collection by Custodial Services. Never use a lab glass box for the disposal of chemicals, sharps, biohazardous materials, or liquid waste.

## K. INFECTIOUS OR BIOLOGICAL WASTE

For infectious or biological waste disposal requirements, refer to Section 4.F of the UW Biosafety Manual. For general information about infectious or biological waste visit the EH&S website.

For disposal of biological specimens stored in chemical solution, first separate the specimen from the solution. Follow infectious or biological waste disposal requirements for disposal of the specimen and submit a chemical waste collection request for disposal of the solution. If you are unsure about how to manage the waste, submit a Waste Evaluation Request or email chmwaste@uw.edu.

## L. RADIOACTIVE WASTE

For radioactive waste, refer to the UW Radiation Safety Manual, Section 14.

## M. MIXED WASTE

Most mixed wastes consist of low-level radioactive wastes combined with hazardous chemicals. UW policy, as well as state and federal law, prohibit the disposal of mixed waste. There is no means for disposing of mixed material. If a lab attempts to dispose of mixed waste, as either radioactive waste or chemical waste, the fines and penalties to the UW will be severe and could result in a Cease-and-Desist Order. Fines and fees of up to $250,000 per year may be assessed against the UW by federal and state agencies if mixed wastes were generated and/or stored on campus.

Exceptions to the production of mixed waste include liquid scintillation cocktails (LSC), which can be legally shipped to a contract waste disposal vendor to be burned, and radioactive materials mixed with a hazardous component that can be neutralized or deactivated in the laboratory.

## N. LIQUID SCINTILLATION COCKTAILS

Several LSC manufacturers now produce non-hazardous fluids, some marketed as being sanitary sewer disposable. There are currently only a few LSCs approved for sanitary sewer disposal by the State of Washington. For more information refer to the Liquid Scintillation Fluid focus sheet.

## O. ANIMALS AND ANIMAL BY-PRODUCTS

Special consideration is needed when disposing of dead animals, animal body parts/tissues, animal bedding or animal waste.

### 1. Contaminated Animals and Animal By-Products

Animals and animal by-products contaminated by infectious agents, radioactive materials, or highly toxic chemicals or stored in fixatives require special disposal procedures. Contact EH&S at 206.221.7770 for disposal guidance.

### 2. Non-Contaminated Animals and Animal By-Products

Some non-contaminated animals and animal by-products may be disposed of as municipal waste. Contact the UW Department of Comparative Medicine at 206.221.3396 to receive instruction on correct procedures, and/or make arrangements to deliver the whole carcass to them for disposal.

## P. GAS CYLINDERS

Gas cylinders used on campus must be either rented or purchased from the preferred supplier, Linde (formerly known as Praxair), if possible. This ensures the cylinders can be properly disposed of and have a return authorization program for unused gas. As applicable, gas cylinders should be marked FULL / PARTIAL / EMPTY and returned to the supplier. Shipping cylinders that are not empty

require shipping precautions as described on the compressed gas webpage.

Any non-returnable cylinder must be disposed of through EH&S. Cost of disposal will be charged to the purchaser. Any abandoned cylinders will be recharged to the associated department. Cylinders or lecture bottles containing an unknown substance must be analyzed prior to disposal. Currently, the cost of analysis on an unknown cylinder is approximately $1,600 per cylinder and is paid for by the laboratory.

If the cylinder contains an atmospheric gas, then remove the valve. For empty propane cylinders, remove the valve stem with a valve stem removal tool. Refer to the  for more information: www.ehs.washington.edu/resource/chemical-waste-guide-facilities-services-566. For assistance with the disposal of gas cylinders, complete and submit a Waste Evaluation Request or email chmwaste@uw.edu.

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# SECTION 4 - LABORATORY EQUIPMENT AND FACILITIES

***Contents***

## A. EMERGENCY EYEWASHES AND SHOWERS

Emergency washing equipment is required when using corrosives (acids and caustics), strong irritants (which cause inflammatory effects upon contact) and toxic materials that can be absorbed through the skin. Emergency washing facilities must be accessible, located so that it takes no more than ten seconds to reach (or < 50' away), accessed through no more than one door, kept free of obstacles blocking their use, function correctly, and provide the quality and quantity of water that is satisfactory for emergency washing purposes. Equipment must be always accessible without requiring a key or overcoming other security safeguards. Ensure that no items are stored within a minimum 16-inch radius from the center of emergency showers. Electrical equipment that is rated "For Indoor Use Only" must be stored at least four feet away from the center of emergency showers or must be adequately guarded against splashes. Electrical outlets must be GFCI rated within six feet of eyewashes and emergency showers.

### 1. Eyewash Stations

If chemicals can cause eye damage and are used in such a way that they may splash into eyes, an eyewash station is required. Laboratory personnel must be able to reach eyewash stations within ten seconds. The eyewash should be within 50 feet of where chemicals are being used, although this distance should be less if doors interfere with access. Always maintain clear paths to eyewash stations.

Chemicals can cause blindness or instant pain, which can make it very difficult for someone to find the eyewash on their own in an emergency. Laboratory personnel should know the location and operation of the eyewash stations in their area. It is recommended that personnel practice locating the eyewash station while keeping their eyes closed. If possible, don't work alone when working with these chemicals.

Eyewashes must be flushed weekly by laboratory personnel to ensure they are operating correctly and the flushing must be documented, in accordance with WAC 296- 800-15035. Weekly flushing checks that eyewashes work and provide a strong enough stream of water to reach the eyes of someone bending over it and help keep the water clean. During the weekly check, the eyewash should be operated long enough (30-60 seconds), so that there is no visible rust or contaminant in the water. If the eyewash is located in a shared area, an individual should be appointed to perform the weekly test. All groups using the shared area should have access to the flushing records and know where they are stored.

### 2. Safety Showers

Laboratory personnel should know the location and use of the emergency showers in their area and be able to reach showers within ten seconds. Always keep the area underneath the shower and the path to the emergency shower clear.

Safety showers are tested annually by Facilities Services. A tag indicating the most recent test date should be found on the equipment. Contact Facilities Services (Appendix F) if a test or maintenance is needed.

### 3. Drench Hoses

A drench hose is an emergency washing device connected to flexible hose used to irrigate and flush the face or other parts of the body. Drench hoses may fill the purpose of an eyewash if installed in the proper location and with the proper eyewash attachments; however, they are not a replacement for emergency showers in areas where they are required. Contact EH&S at 206.543.7388 if you have questions.

## B. FIRE SAFETY EQUIPMENT

### 1. Fire Extinguisher

#### a. Proper Use

Portable fire extinguishers are provided in University buildings and are available for use by trained personnel. All laboratory personnel should be trained to use the type(s) of fire extinguishers that are present in the laboratory. Training classes are available through EH&S. Register online. Individuals who have been trained in the principles of fire extinguisher use and the hazards involved may attempt to extinguish small (trash can or smaller) and early-stage fires if there is an escape route. Individuals not trained in the proper use of extinguishers should not attempt to use one during a fire. Doing so could put them and others in danger.

**b.** Fire extinguishers should be conspicuously located, wall mounted, and easily accessible. Contact Facilities Services to have fire extinguishers mounted. Fire extinguishers may not be obstructed or obscured from view by equipment or other items stored in the lab. Types of Extinguishers

The fire extinguishers available to the laboratory personnel should be selected based on the materials inside or outside the lab. (Refer to Table 4-1 for the list of fire classes).

***Table 4-1 Classes of Fires and Proper Fire Extinguishers***

| Class of Fire | Description | Proper Extinguisher |
|---|---|---|
| A | Ordinary combustibles such as wood, cloth, and paper | Dry Chemical (ABC) or water |
| B | Flammable liquids such as gasoline, oil, and oil- based paint | Carbon Dioxide (BC) or Dry Chemical (ABC) |
| C | Energized electrical equipment including wiring, fuse boxes, circuit breakers, machinery, and appliances | Carbon Dioxide (BC) or Dry Chemical (ABC) |
| D | Combustible metals (e.g., Na, Mg) | Special Extinguisher (D) |

University laboratories using hazardous chemicals should have an ABC rated dry chemical fire extinguisher located within 50 feet of the hazard, either along the exit path from the laboratory or in the hallway adjacent to the laboratory.

Many fire extinguishers on campus are ABC, which perform well on most fires with one major exception: combustible metal fires. Combustible metal (Class D) extinguishers are not typically provided for laboratories unless needed.

Laboratories also may request a $CO_2$ extinguisher (Class BC). It is not as effective as a dry chemical extinguisher but will require less clean up after use

#### c. Maintenance

On the Seattle campus, extinguishers are certified annually by Facilities Services as part of the routine building maintenance. If an extinguisher needs to be refilled, contact Facilities Services or call 206.685.1900. To request additional or alternative extinguishers, contact EH&S at 206.685.0341. For repair or replacement of fire extinguishers at Bothell or Tacoma campuses, please refer to Appendix F.

#### d. Additional fire suppression resources

Automatic fire suppression systems are found in a decreasing number of fume hoods and are being removed as equipment is replaced. Fire hoses may only be used by fire department personnel. Fire blankets are not recommended for laboratory use because they may trap heat in when a victim has burning clothes and cause more injury than would otherwise occur.

### 2. Flammable Storage Cabinets

Flammable storage cabinets are required if you are storing over ten gallons of flammable liquids. Flammable storage cabinets are not fireproof. Cabinets are designed to protect the contents from extreme temperatures for a limited time only. Cabinets must not block egress and cannot be located above sinks or drains. They should not be vented . Contact EH&S at 206.685.0341 for further information on flammable storage cabinets.

#### a. UL listed

Flammable liquids should be stored in an Underwriter's Laboratory (UL) listed flammable liquid storage cabinet outfitted with approved automatic or self-closing doors. All new cabinets must have UL listing or be constructed per the fire code. (Note: Some existing wooden cabinets not UL listed are still in service and approved for use.)

#### b. Label

Cabinets must be labeled "Flammable - Keep Fire Away".

#### c. Capacity

Do not overfill cabinets—check manufacturer's recommendations for storage limits.

#### d. Bottles

All bottles should be placed on the shelves in an upright position and never stacked. Keep all containers tightly closed.

#### e. Containers

Only containers designed for flammable liquid storage may be used. Never use makeshift containers, such as a plastic cup, even for short-term or temporary storage.

#### f. Incompatible Chemicals

Do not store incompatible chemicals in these cabinets. Flammable solids must be segregated from flammable liquids via secondary containment.

#### g. Cabinet doors

Cabinet doors should never be propped open unless the mechanism is a designed part of an approved cabinet.

#### h. Unapproved Storage

The tops of cabinets are not storage shelves. Do not store combustible materials on or beside flammable storage cabinets.

### 3. Flammable Storage Refrigerators

Flammable chemicals, or chemical mixtures that need to be stored below room temperature, must be stored in UL-listed flammable material storage refrigerators or freezers. These refrigerators and freezers are specifically designed by the manufacturer to have non-sparking interiors. Explosion-proof refrigerators are designed to prevent ignition of flammable vapors or gases that may be

present inside but also outside the refrigerator. This type of refrigerator must be used in locations where a flammable atmosphere may develop at some time in the room, such as solvent dispensing rooms. All laboratory refrigerators and freezers must be prominently labeled with a warning sign indicating whether it can be used for flammable or non-flammable storage. For these warning signs or information regarding a flammable storage refrigerator purchase, contact EH&S at 206.685.0341. Refer to the Lab Refrigerators and Freezers focus sheet for more information.

## C. LABORATORY SIGNS

A list of required signs is provided in the following table and explanatory material is described in the following paragraphs.

***Table 4-2 Safety Related Signs***

| Safety-Related Required Signs | Refer to Paragraph |
|---|---|
| Lab Caution Sign | 4.C.1 |
| Emergency/Safety Equipment Location Signs | 4.C.4 |
| Hazards Warning Signs | 4.C.5 |
| "Natural Gas Emergency Shut Off Valve"<br>(*Must be posted if a valve is present.) | 4.C.6 |
| "Laboratory Water – Do Not Drink"<br>(*Must be posted on non-potable water outlets.) | 4.C.7 |

### 1. Lab Caution Sign

A standard University Lab Caution Sign is required to be posted in a Plexiglas holder above or near the room number placard at each lab entrance that has a door or barrier. The purpose of the sign is to warn emergency responders and visitors of potential hazards in the lab and to meet multiple regulatory requirements.

Lab caution sign holders are provided by EH&S. The signs are printed out and updated by lab personnel using a tool in MyChem. It is the responsibility of the lab personnel (PI, Lab Manager, CHO, etc.) to update the signs if significant changes occur in chemical inventories, entry requirements, hazardous materials authorizations, or lab contacts.

The lab caution sign consolidates signage requirements for National Fire Protection Association (NFPA) 704 Hazardous Materials, biohazardous and radioactive materials authorization, entry requirements, food and drink prohibitions and lab contact information.
There are two kinds of caution signs – room signs and suite signs. Post a sign at each entrance to areas or rooms with multiple entrances and show the same information on each sign. Rooms within a room (or rooms accessible only from another room) are considered part of a suite. Post a suite sign at each main/primary entrance, and post room signs at the entrances of the inner rooms. List all room numbers on the suite sign. Within a suite, only rooms that have a door and are used as lab spaces need a room sign. Alcove spaces, open benches, and corridors within a suite that are identified with a room number do not get their own room sign. All labs that have spaces/alcoves/corridors/inner rooms which are part of a suite must identify each space/alcove/corridor/inner room by room number on the suite sign for that suite. The inventories of all the spaces and rooms within the suite are combined and reflected on the suite sign for the suite they are part of via the Caution Sign Tool in MyChem. Suites within a suite will not be listed on the same caution signs.

Any rooms which are not used for chemical or wet lab work but are still lab spaces (procedure room, microscope room, autoclave room, etc.) should have a caution sign, even if the chemical diamond

shows only zeros and no PPE is required.

An example of the sign is shown in Figure 4-1 below. More information on the contents of the signs is available on the Caution and Warning Signs webpage.


*Figure 4-1 Example Laboratory Caution Sign*

## 2. Emergency Procedures for Laboratories

Laboratories should post copies of the Emergency Response and the Spill Response posters in easily visible locations for reference during an incident, accident, or emergency.

Emergency contact numbers for the lab should be posted in the lab in a prominent location. Provide numbers for PI and lab personnel to be called in case of fire, accident, hazardous chemical spill, or another emergency.

## 3. Laboratory Floor Plan

A floor plan showing the evacuation route(s) and locations of spill kits, fire extinguishers and other safety equipment should be included in the *Chemical Hygiene Plan* (CHP) and posted prominently in the laboratory (refer to Appendix C for example laboratory floor plan). If particularly hazardous substances are used in a designated area, the floor plan showing the designated area is mandatory. Floor plan templates are available on the EH&S website.

### 4. Emergency/Safety Equipment Location Signs

Signs must be posted identifying the location of exits, safety showers, eyewash stations, fire extinguishers,
first aid equipment, flammable storage cabinets and other safety equipment. Contact Facilities Services at careteam@uw.edu to post these signs.

### 5. Hazards Warning Signs

Warning signs and labels should be posted in areas or on equipment where hazards exist, such as biohazards, lasers, ultraviolet light, radiofrequency, magnetic fields, X-ray radiation, radioactive materials, high voltage, restricted access or particularly hazardous substance control areas when the hazard is present. These signs may be mandatory depending on the degree of hazard (or as listed in local codes). Contact EH&S at 206.543.7262 for information on hazard signs.

### 6. Natural Gas Emergency Shut Off Valve

If the laboratory has an emergency shut-off valve for gas supply systems, post a sign indicating its presence.

### 7. Laboratory Water – Do Not Drink

If a non-potable water system (lab water) has outlets in the laboratory, such outlets must have signs posted identifying that the “water is not fit for drinking”.

## D. LABORATORY VENTILATION

Washington State L&I has set full shift (eight hour) and short-term (15 minutes) permissible exposure limits (PELs) for many chemicals to prevent adverse health effects in workers (refer to Section 5.A.1). Local exhaust ventilation systems (such as fume hoods) may be needed in order to control airborne contaminants and reduce exposure levels to acceptable limits.
For assistance in measuring chemical exposures, contact EH&S at 206.543.7388.

### 1. Laboratory Design

#### a. Room Air Pressure

Room air pressure should be negative to the hallway so that accidental releases are kept in the lab and not released into the hallway and the building.

#### b. Vents

Do not block or cover supply and exhaust vents. Occupant changes to lab ventilation may compromise the safety features of the laboratory and local exhaust systems such as fume hoods, biosafety cabinets, etc.

### 2. Fume Hoods

A fume hood is local exhaust ventilation equipment that vents separately from the building’s heating, ventilation, and air conditioning (HVAC) system. The primary means of controlling airborne chemical exposure is a fume hood. Fume hoods should be used when working with toxic compounds or compounds with a boiling point below 120°C. (However, some aqueous solutions may be an exception to this rule.) It may be necessary to use a closed system, such as a glove box or bag, for highly hazardous chemical materials.

EH&S maintains a roster of fume hood designs which have been approved for purchase. Refer to Fume Hood webpage for details.

#### a. Fume Hood Use

- **Training** – Personnel using fume hoods should take the on-line training class.
- **Verify Operation** – Make sure the fume hood is operating before starting work. Some new fume hoods have monitoring devices that indicate acceptable working conditions. Otherwise, a strip of Kimwipe™ taped to the underside of the sash can be used as an indicator of air flow. Since this strip may flutter even when the air flow is inadequate, the strip should be placed and its movement observed when you know that the air flow is proper—such as when EH&S measures the air velocity.
- **Exhaust Fan Speed** – Some older buildings have fume hoods equipped with two-speed exhaust fans with local control at the hood. The low exhaust setting is only appropriate for storage. The high setting provides protection for working with chemicals.
- **Minimize Cross Drafts and Eddy Currents** – Air flow into the fume hood is adversely affected by cross drafts and eddy currents. Cross drafts occur when people walk in front of a fume hood or when nearby windows or doors are open. Eddy currents occur around the person using the fume hood and around objects inside it. To limit these effects, fume hoods should not contain unnecessary objects and the slots within the fume hood which direct air flow must not be blocked. The slot at the rear of the work surface is essential for proper air movement. If large pieces of equipment or large numbers of bottles are placed in front of the slot, they should be raised up on blocks or placed on a shelf to allow air to flow into the slot. Equipment should be placed as far to the back of the fume hood as practical, leaving six inches at the rear. Work should be performed at least six inches inside the fume hood opening to prevent cross drafts and eddy currents from pulling contaminated air out of the fume hood and into the room.
- **Sliding Sashes** – The sash should be kept as low as possible to improve overall performance of the hood. The more closed the sash is, the better protection from an unexpected chemical reaction. Procedures should be done with the sash at the level of the maximum approved sash height marking or lower. Use a separate safety shield, such as a face shield, when working with an open sash.
- **Chemical Evaporation** – It is illegal to evaporate chemicals in the hood to dispose of them. Any open apparatus used in hoods which emit large volumes of volatile chemicals should be fitted with condensers, traps, or scrubbers to contain and collect hazardous vapors or dusts.
- **Storage** – Do not store chemicals or supplies in the fume hood. Chemicals and supplies should be stored in the appropriate approved cabinets.
- **Flammable Liquid Vapor** – Laboratory fume hoods are designed to reduce flammable vapors below lower explosive limits when properly operated and maintained. As an added precaution, use only non-sparking and explosion proof electrical equipment (hot plates stirring plates, and centrifuges) in fume hoods where a large volume of flammable liquid vapor may be generated. Take care with using flammable liquids around heat sources.
- **Containers** – All containers of chemicals inside the fume hood must be securely capped when not in use. A rule is that containers should be open for minutes (at the most) – which is the maximum time it normally takes to pour a small amount of chemical into another container and replace the cap. All containers must be labeled with the chemical identity and appropriate hazard warnings (or the material must be used up during the work period and be under continuous control of the researcher using it).

- **Obstructions -** Avoid placing equipment, cabinets, furniture or fixed units of any kind directly in front of the fume hood. Improper airflow in the fume hood or the inability of people to work safely in the fume hood may result in potential injury. Remove all material and equipment that block access to the fume hood.

**b. Fume Hood Prep for Maintenance**

Prior to any maintenance of fume hoods, the entire interior surfaces must be decontaminated and/or cleaned by the researchers using the hood (as described below in Section 4.G.2 Decontamination of Equipment for Service).

Maintenance may require access to storage cabinets below or to the side of the hood. If access is required, the entire cabinet and adjacent area also needs to be emptied, decontaminated, cleaned and rinsed. Lab personnel need to identify a contact for coordinating with Facilities Services regarding the work to be done. Refer to Section 4.G.2 for details and the required maintenance request form.

**c. Fume Hood Performance and Testing**

EH&S performs a functional performance test every 12-18 months to assure hoods are performing as designed. If a hood's performance fails, it may need to be taken out of service until repaired. EH&S will notify the researchers and post a "Do Not Use" sign if repair is required.

Fume hoods can be tested using up to five functional performance criteria, depending upon the fume hood design. This criteria includes face velocity, variable air volume (VAV) tracking, sound, and containment to monitor functionality. Specific performance measures for each test are outlined below. For more information, contact EH&S at 206.543.9510.

**d. Face Velocity**

- Standard Flow Hoods: 80 – 120 Feet Per Minute (FPM).
- Sash height should not be less than 18 inches.
- High-Performance Hoods: 60 – 84 FPM.

**e. Variable Air Volume Tracking**

The sash is lowered about 50% from the target sash height to assure the HVAC system responds appropriately to maintain optimal capture velocity.

**f. Sound**

Measure sound using a sound meter on Scale A with the sash optimized and the sound meter located about one foot from the front of the hood at 18 inches above the work surface (roughly ear level of the testing technician). The ambient sound level must be less than 80 dBA.

**g. Containment Test**

Use visual powder or dry ice; check for effective containment.

**h. Monitor Alarm Properly Functioning**

- Confirm monitor has power and is properly calibrated.
- Raise sash to reduce face velocity below 80 LFM (60 LFM for low - flow fume hoods) and to confirm that both visible and audible alarm signals function.
- Test monitor's mute function by pressing the mute button.
- Test the reset button.
- Test Failure: Monitor fails to alarm, is more than 10 FPM out of calibration, fails any functional test, or is damaged.

#### i. Fume Hood Problems

If you are having problems with your fume hood, contact EH&S at 206.543.9510. EH&S will troubleshoot the problem and may refer it to UW Facilities for repair.

### 3. Perchloric Fume Hoods

Procedures using concentrated perchloric acid (>70%) or which heat any amount or concentration of perchloric acid must be performed in a closed system or within a specially designed perchloric acid fume hood with wash down systems to prevent the accumulation of explosive perchlorates in the hood and ducting. For assistance in locating a perchloric acid fume hood, call EH&S at 206.221.5549.

### 4. Glove Boxes

Glove boxes generally operate under either positive or negative pressure to the lab, depending on the process or material used. Positive pressure glove boxes are used when you are trying to protect your material from contamination. Negative pressure glove boxes are used to provide increased operator protection. Glove boxes should be thoroughly tested before each use and there should be a method of monitoring the integrity of the system (such as a pressure gauge).

### 5. Biological Safety Cabinets

Biological safety cabinets (BSCs) are laboratory hoods designed to protect the worker and the experiment by drawing air across the samples and away from the worker and into a HEPA filter. There are two types of BSCs. Class II type A and Class II type B1 units recirculate filtered air into the laboratory and are not designed for chemical use for this reason. The Class II type B2 unit is designed for use of some chemicals, but is not a substitute for a fume hood. The use of chemicals in this type of hood needs to be evaluated carefully so that the protective barrier (HEPA filters) is not destroyed by the chemicals.

BSCs are certified annually by EH&S. If a BSC fails the certification, it may not be used until repaired, unless specifically authorized by an EH&S Biosafety Officer. BSCs may not be repaired or moveduntil decontaminated by EH&S.

EH&S does not support the use of UV lights in BSCs. Laboratories are solely responsible for maintaining any UV lights in their cabinets and will need to use outside contractors for servicing. BSCs with UV lamps should be labeled with a UV Light Source Caution sticker. Contact radsaf@uw.edu to get a sticker for your cabinet.

Refer to the EH&S Focus Sheet Chemical Use in Biological Safety Cabinets for information about using chemicals in a BSC.

For additional information on the proper use of BSCs, Class II type B2 design, cabinet certification, troubleshooting problems or decontamination contact EH&S at 206.543.9510.

### 6. Laminar Flow Hoods

Laminar flow hoods are designed to protect the work surface from contaminants and may blow out into the face of the person using the hood. Therefore, any chemical use will cause the person to be exposed to the chemical. Toxic or volatile chemicals may not be used in a laminar flow hood.

### 7. Ductless Laboratory Hoods

In some cases, installation of a ducted fume hood may be impossible, and a request for a ductless hood must be approved by EH&S. This type of device uses special filters or absorbents to clean the contaminated air in the hood prior to recirculating the air back into the room.
Recirculation of potentially contaminated air into the room presents special dangers and special

requirements must be met.
The requesting department must demonstrate that the following concerns are addressed as long as the hood is in use:

**a. Chemical Characterization**

Each of the chemicals to be used in the ductless hood must be completely characterized as to the quantity which may be released within the hood at one time and the frequency of use. The hood manufacturer will need this information for the design of the hood. Once designed, use of other chemicals in the hood must be forbidden unless the hood manufacturer approves the alternate chemical. Records as to the design of the hood and the designated chemical usage must be maintained in the laboratory.

**b. Ductless Hood Approval**

The RP must verify that the size, shape, and layout of the proposed hood, as offered by the hood manufacturer, is appropriate for the intended use. The RP must also develop a management plan for the hood which addresses personnel training and procedures for using the hood, including emergency procedures, ongoing maintenance, certifications for the hood and recordkeeping. This plan needs to assure continuity if management of the hood is taken over by another individual. A description of the items required in the management plan is available from EH&S at 206.543.7388. Hood approval by EH&S is contingent on submittal of the hood design information from the proposed manufacturer and submittal of the management plan.

**c. Laboratory Personnel Information and Training**

All personnel in the laboratory must be trained that the ductless hood recirculates air back into the room, that only certain designated chemicals may be used within the hood, and that failure to operate properly and maintain the hood may result in personnel exposures.

Also, a sign must be placed on the hood identifying which chemicals may be used and warning that the air is recirculated back into the room from the hood.

## 8. Cold Rooms, Warm Rooms and Environmental Chambers

**a. Room Design**

Controlled environmental rooms are generally completely enclosed, with no fresh air, and with heating/cooling and other environmental systems independent of the building.
Rooms large enough to enter should be designed or retrofitted with doors that allow anyone trapped inside to get out easily. The electrical system within environmental rooms should be independent of the main power supply so that people are never left in these areas without light.

The use and storage of flammable liquids in cold rooms is not allowed except following a review by EH&S. These rooms are not typically constructed to be fire rated.

Mold growth can occur in cold rooms when ambient humidity is high, where there is poor ventilation, insulation failure, or when wood, cardboard, and other porous materials that can grow mold are stored in the room. Prevent mold growth in cold rooms by following the guidance in the Mold in Cold Rooms Focus Sheet.

**b. Chemical Use**

Controlled environment rooms usually recirculate the air using a closed air-circulation system. Hazardous chemicals must not be stored in these rooms because ambient concentrations of volatile chemicals can accumulate to dangerous levels.

Flammable solvents should not be used in controlled environment rooms. Ignition sources in these

rooms could ignite vapors.

Avoid using volatile acids in cold rooms because vapors can corrode the cooling coils, leading to possible refrigerant leaks.

If solid carbon dioxide (dry ice) is placed into a cold room, its sublimation will raise the carbon dioxide levels within the room, possibly to dangerous levels. Use extra precautions if you must use or store dry ice in these spaces.

## 9. Other Ventilation Systems

A ventilation engineer must design all other local exhaust systems used in the laboratory. Do not attach canopy hoods or snorkel systems to existing fume hood exhaust ducts without consulting a ventilation engineer at Seattle Facilities Services, Campus Engineering, 206.543.7372 or your local campus engineering design services (if available). All local exhaust systems should have a visual indicator that the system is functioning properly at all times, even if the indicator is just a Kimwipe™.

### a. Discharge of Hazardous Vapors

Laboratory apparatus that may discharge hazardous vapors (vacuum pumps, gas chromatographs, liquid chromatographs, and distillation columns) must be vented to an auxiliary local exhaust system such as a canopy or a snorkel, if not already vented to a fume hood.

### b. Hazardous Chemicals

Hazardous chemicals should be stored in approved cabinets.

### c. Isolation/Clean Rooms

Isolation rooms typically operate under negative pressure and clean rooms typically operate under positive pressure to the anterooms or hallways. These rooms require considerable engineering. Procedures for entering and exiting these areas should be written out and employees should be trained accordingly.

## 10. Maintenance of Ventilation Systems

All ventilation systems need routine maintenance for blocked or plugged air intakes and exhausts, loose belts, bearings in need of lubrication, motors in need of attention, corroded duct work and minor component failure. Contact Facilities Services (refer to Appendix F) if a ventilation system has a problem. When maintenance is scheduled for fume hood exhaust systems, researchers should receive notification. Warning signs should be posted on the affected fume hoods, sashes must be closed, and researchers must cease fume hood usage during the maintenance procedures. Ensure all chemical containers are closed and sealed and hazards are managed appropriately.

### a. Filters

Filters should be replaced periodically in certain types of ventilation systems, such as electrostatic precipitators, cyclones for dust collection and BSCs. For laboratory-maintained equipment, keep a record of these filter changes as part of your safety documents that can be easily located in case a regulatory agency requests a copy of this documentation.

### b. Monitoring Devices

Monitoring devices should be included in new ventilation systems to make the user aware of malfunctions. All personnel within the laboratory need to understand the meaning of associated alarms and readout devices and the actions to take if an alarm or unacceptable reading occurs.

## E. OTHER FACILITY CONDITIONS

### 1. General Laboratory Environment

Work surfaces (e.g., bench tops, counters, etc.) and furniture should be impervious to the chemicals and materials used in the laboratory to support maintenance and the ability to clean them. Laboratory furniture must be capable of supporting anticipated loads and uses. Bench tops are required to be impervious to water and resistant to acids, alkalis, organic solvents and moderate heat. In addition:

- Do not have carpets and rugs in the lab.
- When possible, allow spaces between furniture and equipment for cleaning.
- Cover furniture with a non-porous material for easy cleaning.

#### a. Building Repairs and Alterations

Building occupants are not authorized to repair or alter facilities. Facility problems such as broken flooring and broken electrical cover plates should be corrected by initiating a work request with Facilities Services (refer to Appendix F).

#### b. Floors and Walkways

1. **Flooring** – Floors should be level, with no protuberances which could cause a tripping hazard. Openings in the floor should be covered, if possible, or else protected or guarded to prevent falls. If impervious mats are present, they should have a non-slip backing or be fastened to prevent moving when someone steps on them. Material spills should be cleaned up as soon as possible.
2. **Obstructions** – Equipment and supplies should not be placed in corridors and pathways where it would interfere with exiting or make exiting hazardous. For more information, refer to the UW Corridor Policy.

#### c. Doors

Doors to laboratories and chemical use areas should remain closed when not actively in use. Fire rated walls and doors serve to compartmentalize the building into smaller fire zones and provide safe exit passage in the event of a fire. Even in areas without rated construction, lab doors help maintain a properly functioning ventilation system. Labs and chemical use areas are designed to sit at a negative pressure to keep contaminants within the space and protect the surrounding areas.

Propping open these doors defeats the ventilation design. Lab doors are also important to restrict access to hazardous materials and provide security for the area and employees. Certain processes and hazardous chemicals require doors not only to be closed but also locked.

#### d. Wall and ceiling penetrations

The integrity of walls and ceilings, including suspended ceiling tiles, should not be compromised without prior approval. Do not punch holes in ceiling tiles to run piping, run electrical lines, or for any other reason. Penetrations can affect room ventilation and lessen the effectiveness of sprinkler and fire alarm systems, among other impacts. They may also expose occupants to regulated building materials.

#### e. Seismic Bracing and Earthquake Preparedness

Details concerning seismic bracing are noted in Section 9.A.1.f. Facility Services must perform all facility modification, such as installing mounting brackets on the walls.

### f. Plumbing Systems

Place a strainer or mesh pad over all sink drains to prevent objects from falling into the plumbing. Piping systems and plumbing connections in a room should be labeled. Such plumbing systems may include sewage lines, potable water lines, non-potable water systems, cryogenic and pressurized gases, or other systems. All personnel should know what to do in case of a leak in any system.

If experimental procedures will require connecting laboratory apparatus to any plumbing, personnel must also know how to avoid improper connections (i.e., avoiding mistakes such as connecting to the wrong system or making an inappropriate cross connection). Public Health regulations require additional safeguards to the plumbing system when connecting chemical equipment or experiments to potable water systems. Check with EH&S and UW Facilities prior to adding or changing any connections to potable water systems.

When cupsinks in fume hoods are not in use, cover or block them with an appropriate material to prevent chemicals from accessing the plumbing and sewer systems in the event of a spill.

### g. Lighting

1. **Light Fixtures** – Light fixtures should be operational, and diffusers should be installed. If emergency lighting and exit signs are not functional, immediately initiate a work request with Facilities Services (refer to Appendix F).
2. **Lighting Intensities** – Light intensities should be adequate for the tasks being performed. If lighting seems inadequate when all fixtures are working, consider obtaining additional fixtures, especially if the laboratory arrangement is temporary. If this will not resolve the problem, call EH&S at 206.543.7388. In a few cases, increased lighting may be required to reduce potential hazards from activities such as laser use or ultraviolet light applications. In these situations, contact EH&S Radiation Safety at 206.543.0463.

### h. Noise and Vibration

When possible, equipment that produces irritating noise and vibration should be replaced with equipment designed to produce less noise and vibration. If equipment in the area is producing noise levels that require people to raise their voices to be heard while standing next to each other, potentially hazardous noise levels are being produced. These levels can be evaluated by contacting EH&S at 206.543.7388.

Equipment which produces noise levels greater than 80 dBA should not be purchased without specific written approval from EH&S at 206.543.7388. A formal hearing protection program may need to be implemented for the installation and use of such equipment.

### i. Indoor Air Quality

1. **Occupant Activities** – Many complaints about odors are due to occupant-generated problems. Such sources include dried out drain traps in sinks and floor drains, chemical spills inside a laboratory or adjacent area, rotting food within a room, and expected or unexpected chemical reactions creating a stench. The room occupants should check these potential problems. If a dry trap is suspected, the trap should be filled with a few hundred milliliters of water at least once a month, or infrequently pour ten or twenty milliliters of a slower evaporating chemical such as glycerin, propylene glycol (not ethylene glycol) or mineral oil into the drain. Additional information about unknown odors is available on the Indoor Air Quality webpage.
2. **Facility Related** – Recurring poor indoor air quality may be due to inadequate or

malfunctioning general HVAC systems. In some cases, odors may come from a leak in a plumbing system (such as natural gas or sewage), an open drain that was never capped by Facilities Services when a piece of equipment was decommissioned, or a construction project in an adjacent area. If these conditions are suspected, contact Facilities Services (refer to Appendix F).

3. **Unknown Odor** – If an unknown odor persists, contact EH&S at 206.543.7388.

**j. Asbestos, Lead and Other Hazardous Laboratory Components**

1. **Asbestos** – Asbestos may be found in various equipment components, such as fume hood and safety cabinet wallboards and in autoclave and oven gaskets, and various supplies, such as heat-resistant gloves and heat-resistant cloth. Non-asbestos materials should be used whenever possible in place of the asbestos materials, and all personnel should avoid damaging suspected asbestos-containing materials. Do **NOT** use an ordinary vacuum cleaner or dry sweep to clean up suspect dust from these materials. Such materials are handled by a contractor via a work order through Facilities Services. Contact EH&S at 206.543.7388 concerning asbestos questions.
2. **Lead** – Lead may be used in a lab as a barrier when density is needed (such as an x-ray radiation shield) or as a weight when a heavy material is needed (such as an equipment counterbalance). The primary health hazard would come from inhaling or ingesting dusts from these materials, but skin contact with these materials should also be minimized. If a laboratory operation routinely creates lead dust or melts lead, the process should be evaluated by EH&S at 206.543.7388.
3. **Other Materials** – Other laboratory materials that could present a health hazard include polychlorinated biphenyls (PCBs) in light fixtures, window caulking/putty and transformers, liquid mercury switches in piped gas systems, mercury in fluorescent and high-pressure light bulbs, flammable or toxic gases in piped gas systems, and potentially hazardous materials in sewage plumbing and ventilation ducts. If any leak of such material is suspected, contact Facilities Services (refer to Appendix F).

## 2. Electrical Hazards

It is important for personnel to be aware of the hazards electricity may pose, such as shock, fire and explosion, and either eliminate or control electrical hazards. Even small electrical currents passing through the body may cause injury or death. Observe the following precautions to reduce electrical risks. Complete required trainings prior to work starting. Training requirements and more information are on the Electrical Safety webpage.

**a. Circuit Breaker Access**

1. **Access** – Maintain at least three feet clearance in front of any circuit breaker panels within the laboratory.

**2. Utility Access in Other Rooms** – If you must enter other rooms to access the circuit breakers, you must be observant of any conditions in that room which may indicate a hazard. Such conditions could include puddles in front of the circuit breaker box or temporary barriers preventing entry to the circuit breaker box. (If a barrier is deliberately placed, such as a sign indicating that entry is restricted due to a hazard, obtain permission from the agency placing the barrier before entry.)

**b. Permanent Wiring and Outlets**

Request permanent wiring be installed for situations when you would be using extension cords for

periods longer than eight hours. All building electrical repairs and wiring must be done by Facilities Services. If conduits appear damaged or cover plates over electrical outlet boxes are damaged or missing, please report that information to the Building Coordinator for forwarding to Facilities Services or directly contact your supporting Facilities Services organization (refer to Appendix F).

**c. Equipment Cords and Extension Cords**

1. Extension cords should be a minimum 14-gauge size (heavy duty) and in good condition with no splices, knots, deterioration, taping, damage or sharp, permanent bends. Plugs (110 volt) must have three prongs with a grounding prong longer than the current prongs.
2. Extension cords may never be used in place of permanent wiring. Consider instead power strip outlets or surge protectors with built-in circuit breakers. Refer to the Extension Cords, Surge Suppressors and Power Strips focus sheet for guidance on appropriate use of listed power-strips and surge protectors.
3. Daisy-chaining of extension cords and/or power strips is not appropriate in any circumstance.
4. Carpeting, heavy objects, and equipment that may abrade or melt an electrical cord should never be placed on top of electrical cords. Cords should serve only one fixture or piece of equipment. Cords should never be strung through holes in walls or ceilings, or over metal fixtures such as pipes or equipment racks because cord movement may abrade the cord.

**d. Splashes into Electrical Equipment**

Place equipment so as to reduce the chances of a spill of water or chemical on the equipment. If a spill occurs while the equipment is unplugged, the spill should be promptly cleaned and the equipment must be inspected before power is applied.

**e. Grounding of electrical systems**

A facility using water or other liquid conductor that has a likelihood of creating a wet floor or work area should be equipped with ground fault circuit interrupter (GFCI) or equivalent protection within six feet of splash hazards to help prevent a serious electrical hazard in the event of an uncontained leak or other unexpected condition. Portable GFCIs are acceptable.

**f. Equipment Modifications**

Any problems with electrically powered equipment should be brought to the attention of the PI or laboratory supervisor. If equipment setup is modified, someone knowledgeable of the apparatus should check the new setup before power is applied. Equipment operators must understand the hazards of equipment and apparatus in use and be familiar with the correct operation of that equipment. Power line cords should be unplugged before any modifications, maintenance, or repairs are made to equipment. Even though power may need to be applied to equipment while calibrations are performed, the operator must remain wary of the energized state of the equipment and not adjust the equipment beyond safe operational parameters.

If there is a potential for personnel to contact live electrical circuits of 50 volts or greater while performing equipment installation, modification, or maintenance, that person must take electrical safety classes (including lockout/tagout procedures) and wear appropriate arc/flash protective clothing. When possible, equipment setup and maintenance must be performed with the equipment in a de-energized condition.

### 3. Lockout / Tagout Concerns

#### a. Hazardous Situations

In addition to common electrical hazards, other energy hazards may exist in the laboratory that require special procedures, called Lockout/Tagout procedures. These situations may include equipment with internal pressurized systems (hydraulic or gas), multiple electrical energy source systems (where electricity is supplied through more than one cord), systems containing batteries or capacitors, and gravity systems (where a weight is held at a height). Such systems must be labeled with a warning sign. Anyone using such systems must know of the hazards and that only trained and authorized individuals may repair and modify the equipment.

#### b. Precautions

Trained and authorized personnel must perform all repairs, maintenance, and modifications. When repairs, maintenance, and modifications are performed, the energy source must be prevented from being activated using appropriate techniques such as de-energizing the system, inserting blanksinto pressure systems, and locking out controls with individualized locks.

### 4. Equipment Guards and Mounting

#### a.Guards

Belts, pulleys, and other exposed moving equipment parts must be guarded. Equipment covers should be in place.

#### b. Mounting

Equipment designed to be used in a particular location should be permanently fixed in place to prevent movement from vibration or earthquake. This is especially important for equipment which is top-heavy, may topple (e.g., a drill press) or which needs to be balanced (e.g., a centrifuge).

### 5. Confined Spaces

Laboratories may contain equipment (such as large tanks or ovens) or facility arrangements (such as tunnels, sumps, or pits) that laboratory personnel may need to enter. Since potentially hazardous exposures may occur in a confined space, the space will need to be controlled as a permit-required confined space. Special training and other precautions are required for permit-required confined space entry. Contact EH&S at 206.543.7262 for space evaluations and to schedule training.

## F. LABORATORY APPARATUS AND EQUIPMENT

To ensure basic safety of new equipment before purchasing or first use, it needs to be determined that the equipment meets accepted safety standards and requirements including, but not limited to:

- Local fire code requirements for electrical equipment, wiring and hazards(e.g., International Fire Code, 2018 Chapter Six, Section 604)
- Underwriters Laboratories (UL) 61010, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use. UL labeling indicates products that have been tested by independent laboratories and determined to meet UL safety requirements.
- National Fire Protection Association (NFPA) 45 (Chapter 12), Standard on Fire Protection for Laboratories Using Chemicals. Operations and apparatus requirements, such as handling hazardous chemicals, heating operations and refrigeration and cooling equipment used to store flammable and combustible liquids, are covered.

Proper use and maintenance of laboratory equipment can protect the health and safety of both the personnel and the equipment in use. Certain equipment found within labs may warrant greater attention than others depending on the specific hazards present and operation of the equipment.

## 1. General Safety Work Practices

Operator manuals should be available for all lab equipment and instrumentation. Equipment manuals should be available and accessible to laboratory personnel. Personnel using the equipment should know where such manuals can be found and should review the manuals prior to using the equipment. Training on the hazards and usage of equipment should be completed and documented prior to usage.

Although each will have its own specific safety requirements, some general guidelines for operating any lab equipment and instrumentation include the following:

- Always wear PPE recommended by the manufacturer when using the equipment and instrument (i.e.: hearing protection, face shield, etc.).
- Always keep the manufacturer's operating manual with the instrument.
- Follow and document recommended maintenance procedures outlined in the manual.
- New operators should be trained by qualified lab personnel and familiarize themselves with the operating manual, including all pertinent safety information.
- Never remove hazard-warning labels from an instrument.
- Ensure that all equipment is grounded.
- Have a certified technician perform or supervise repairs.
- Disconnect equipment from the power-source whenever conducting maintenance on the instrument. Also, discharge any stored energy sources.
- Do not modify any electrical components. Modifications must be certified by a nationally recognized testing laboratory (e.g., UL, CSA, etc.)
- If the equipment is used near (within six feet) any source of water, ensure that it is plugged into an outlet with a Grounding Fault Circuit Interrupter (GFCI). Note: do not plug continuous running equipment, such as freezers, into GFCI outlets.
- Be aware of and be trained in the unique hazards of your instrument. (i.e.: lasers, UV light, radiation sources, etc.)
- Ensure that routine maintenance is conducted and that maintenance records are maintained in paper or electronic format.

## 2. Refrigerators and Freezers

Refrigeration, whether an appliance or building system, may not be modified or repaired by laboratory personnel. Appropriate Facilities Services personnel or a certified refrigeration mechanic should be contacted to work on these systems. The refrigerant gas must be collected and recycled and must not be released to the environment.

#### a. Labeling

Every refrigerator, freezer and cold room must be clearly labeled to indicate whether it is suitable for storage of flammable, biological or radiological materials. Household refrigerators and freezers must be labeled "Danger-Do not put flammable liquids in this refrigerator/freezer;" food refrigerators and freezers must be labeled "Food Only".

#### b. Flammable units

Household refrigerators and freezers are not equipped with electrical-safe controls and shall not be used to store flammable liquids. A flammable-safe refrigerator/freezer is constructed with its controls mounted outside the storage compartment. This type of refrigerator is suitable for storing flammable liquids and is labeled by the manufacturer as such. Refer to the Lab Refrigerators and Freezers focus sheet.

#### c. Explosion Proof Units

An explosion-proof refrigerator/freezer also has its controls mounted on the outside. In addition, the controls are designed to be explosion-proof. This type of refrigerator/freezer is required in rooms or areas where the use and storage of flammable or combustible liquids heated above their flash point are in amounts where the electrical components are required to meet the electrical code requirements for a hazardous electrical classified location per the National Electrical Code (NEC). This is based on the potential for a release of flammable vapors/gases in a concentration that may result in an explosive atmosphere.

### 3. Stirring and Mixing Equipment

Stirring and mixing devices commonly found in laboratories include stirring motors, magnetic stirrers, shakers, small pumps for fluids, and rotary evaporators for solvent removal. These devices are typically used in laboratory operations performed in a hood and need to be operated so that they do not generate electrical sparks.

Use only spark-free induction motors in power stirring and mixing devices or any other rotating equipment used for laboratory operations. While the motors in most of the currently marketed stirring and mixing devices meet this criterion, their on-off switches and rheostat-type speed controls can produce an electrical spark due to exposed electrical conductors. Do not control the speed of an induction motor operating under a load with a variable autotransformer.

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

### 4. Heating Equipment

Most labs use at least one type of heating device, such as ovens, hot plates, heating mantles and tapes, 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 since their temperature will never exceed 100° C. Ensure the supply of water for steam generation is sufficient prior to leaving the equipment for any extended period.

When working with heating devices, consider the following general precautions

- Enclose heating elements in laboratory heating equipment to prevent laboratory personnel or any metallic conductor from accidentally touching elements or wires carrying electric current.

- Repair or replace worn or damaged heating equipment especially if its heating element is exposed.
- Use a variable autotransformer on a laboratory heating device to control the input voltage.
- Locate the external cases of all variable autotransformers where water and other chemicals cannot be spilled onto them and where they will not be exposed to flammable liquids or vapors.
- Post signage warning of any hot surfaces present

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 because of a loss of water pressure or loosening of a water supply hose to a condenser.

**a. Ovens**

Electrically heated ovens are commonly used in the laboratory to remove water or other solvents from chemical samples and to dry laboratory glassware. *Never use laboratory ovens for human food preparation*.

- Laboratory ovens are constructed so that their heating elements and temperature controls are physically separated from their interior atmospheres.
- Laboratory ovens rarely provide for preventing the discharge of substances volatilized in them. Connecting the oven vent directly to an exhaust system can reduce the possibility of substances escaping into the lab or an explosive concentration developing within the oven.
- Do not dry glassware or any chemical sample that contains flammable materials unless the oven is explosion-proof.
- Do not use ovens to dry any chemical sample that might pose a hazard because of acute or chronic toxicity, unless the oven is continuously vented.
- Do not dry glassware containing organic compounds in an unvented oven.
- To avoid explosion from residual solvent when drying glassware in an oven, rinse glassware with distilled water before it goes in the oven.
- Bimetallic strip thermometers are preferred for monitoring oven temperatures. Do not use mercury thermometers.

**b. Hot Plates**

Laboratory hot plates are normally used for heating solutions to 100° C or above when inherently safer steam baths cannot be used. Ensure any newly purchased hot plates are designed to prevent electrical sparks. Older hot plates pose an electrical spark hazard from either the on-off switch located on the hot plate, the bimetallic thermostat used to regulate the temperature or both. In addition to the spark hazard, old and corroded bimetallic thermostats can eventually fuse shut and deliver full, continuous current to a hot plate.

- Do not store volatile flammable materials near a hot plate.
- Limit use of older hot plates for flammable materials.

- Check for corrosion of thermostats. To avoid a spark hazard, repair or replace corroded bimetallic thermostats.

**c. Heating Mantles**

Heating mantles are commonly used for heating round-bottomed flasks, reaction kettles and related reaction vessels. These mantles enclose a heating element in a series of layers of fiberglass cloth. Heating mantles pose no shock hazard as long as the fiberglass covering is not worn or broken, and as long as no water or other chemicals are spilled into the mantle.

- Always use a heating mantle with a variable autotransformer to control the input voltage. Never plug them directly into a 110-volt line.
- Do not exceed the input voltage recommended by the mantle manufacturer. Higher voltages will cause it to overheat, melt the fiberglass insulation and expose the bare heating element.
- If the heating mantle has an outer metal case that provides physical protection against damage to the fiberglass, it is good practice to ground the outer metal case to protect against an electric shock if the heating element inside the mantle shorts against the metal case.
- Older equipment may have asbestos insulation rather than fiberglass. Contact EH&S at 206.543.7388 for proper handling and disposal of the asbestos.

**d. Oil, Salt and Sand Baths**

Electrically heated oil baths are often used to heat small or irregularly shaped vessels or when a stable heat source that can be maintained at a constant temperature is desired. For temperatures below 200°C, saturated paraffin oil is often used; for temperatures up to 300°C, a silicone oil should be used. Molten salt baths, like hot oil baths, offer the advantages of good heat transfer, but have a higher operating range (e.g., 200 to 425°C) and may have high thermal stability. There are several precautions to take when working with these heating devices:

- Contain heated oil in a sturdy vessel.
- When using oil, salt, or sand baths, do not spill water or volatile substances into the baths. Hot material can splatter over a wide area and cause serious injuries.
- To avoid generating smoke or oil ignition, do not overheat hot oil baths.
- Always monitor the oil bath temperature to ensure it does not exceed oil's flash point.
- Fit oil baths left unattended with thermal sensing devices that will turn off the electric power if the bath overheats.
- Mix oil baths well to ensure there are no hot spots around the elements that heat the surrounding oil to unacceptable temperatures.
- Mount baths carefully on a stable horizontal support such as a laboratory jack that can be raised or lowered without danger of the bath tipping over. Iron rings are not acceptable supports for hot baths.
- Clamp equipment high enough above a hot bath so that if the reaction begins to overheat, the bath can be lowered immediately and replaced with a cooling bath without having to readjust the equipment setup.
- Provide secondary containment in the event of a spill of hot oil.

- Wear heat-resistant gloves when handling a hot bath.
- The reaction container used in a molten salt bath must be able to withstand a very rapid heat-up to a temperature above the melting point of salt.
- Keep salt baths dry since they are hygroscopic, which can cause hazardous popping and splattering if absorbed water vaporizes during heat-up.

**e. Hot Air Baths and Tube Furnaces**

Hot air baths are used in the lab as heating devices. Nitrogen is preferred for reactions involving flammable materials or for when combustible materials are heated above their flash point. Electrically heated air baths are frequently used to heat small or irregularly shaped vessels. Due to low heat capacity, these baths normally have to be heated to 100°C or more above the target temperature. Tube furnaces are often used for high-temperature reactions under pressure. Consider the following when working with either apparatus:

- Ensure that the heating element is completely enclosed.
- For air baths constructed of glass, wrap the vessel with heat resistant tape to contain the glass if it breaks.
- When possible, use sand baths instead of air baths.
- For tube furnaces, carefully select glassware and metal tubes and joints to ensure they can withstand the pressure.
- Follow safe practices outlined for both electrical safety and pressure and vacuum systems.

**f. Heat Guns**

Laboratory heat guns are constructed with a motor-driven fan that blows air over an electrically heated filament, producing temperatures up to 650°C. Applications include:

- Drying glassware
- Heating parts of distillation apparatus
- Developing thin-layer chromatography (TLC) plates
- Removing paint
- Soldering
- Curing epoxy resins
- Removing ice accumulation
- Heat-shrink tubing application
- Removing decals and stickers
- Softening, molding, and welding plastic materials
- Accelerating evaporation

Do not use an extension cord to power a heat gun since they may overheat and cause a fire or electric shock. Never obstruct or cover the air inlet grills or operate the heat gun with the outlet nozzle directly against the surface. This will reduce the air flow, causing the heat gun to overheat and possibly catch fire. Other safety considerations include:

- Do not use a heat gun near combustible or flammable materials/atmospheres.
- Keep in mind the presence and direction of the heat produced.
- Always switch the tool off before putting it down on any surface.
- Allow the tool to cool before storing it.
- Never touch the hot metal nozzle with clothing or skin.
- Never direct the air flow towards one's body.
- Do not look down at the nozzle while the gun is turned on.
- Do not insert anything down the nozzle of the gun.
- Unplug the heat gun when it is not in use.

**g. Microwave Oven**

Use microwave ovens specifically designed for laboratory use. Household appliances are not designed to withstand the hazardous materials utilized in a lab nor the processes in which they are utilized. Household or domestic microwaves should not be used in a laboratory. Microwave heating presents several potential hazards not commonly encountered with other heating methods: extremely rapid temperature and pressure rise, liquid superheating, arcing, and microwave leakage. Microwave ovens designed for the laboratory have built-in safety features and operation procedures to mitigate or eliminate these hazards. Other potential hazards include:

- Generating sparks that can ignite flammable vapors.
- Placing metals inside the oven that may produce an arc and ignite flammable materials.
- Placing materials inside the oven may overheat and ignite.
- Sealed containers, even if loosely sealed,can build pressure upon expansion during heating, creating a risk of container rupture.

To minimize the risk of these hazards:

- To avoid exposure to microwaves, never operate microwave ovens with doors open.
- Do not place wires and other objects between the sealing surface and the door onthe oven. The sealing surfaces must be kept clean.
- Never use a microwave oven for both laboratory use and food preparation.
- Electrically ground the microwave. If use of an extension cord is necessary, only a three-wire cord with a rating equal to or greater than that for the oven should be used.
- Do not microwave flammable or combustible materials.
- Assure proper ventilation by following vendor setup instructions.
- Do not use metal containers and metal-containing objects (e.g., stir bars) in the microwave. They can cause arcing.
- Do not put heat-sealed containers in the microwave oven. Even heating a container with a loosened cap or lid poses a significant risk since microwave ovens can heat material so quickly that the lid can seat upward against the threads and containers can explode.
- Remove screw caps from containers being microwaved. If the sterility of the contents

must be preserved, use cotton or foam plugs. Otherwise plug the container with lab wipes to reduce splash potential. Do not modify a microwave for experimental use.

### 5. Ultrasonicators

Human exposure to ultrasound with frequencies between 16 and 100 kilohertz (kHz) can be divided into three distinct categories: airborne conduction, direct contact through a liquid coupling medium, and direct contact with a vibrating solid.

Ultrasound through airborne conduction does not appear to pose a significant health hazard to humans. However, exposure to the associated high volumes of audible sound can produce a variety of effects, including fatigue, headaches, nausea, and tinnitus. When ultrasonic equipment is operated in the laboratory, the apparatus must be enclosed in a 2-cm thick wooden box or in a box lined with acoustically absorbing foam or tiles to substantially reduce acoustic emissions (most of which are inaudible).

Direct contact of the body with liquids or solids subjected to high-intensity ultrasound of the type used to promote chemical reactions should be avoided. Under sonochemical conditions, cavitation is created in liquids, and it can induce high-energy chemistry in liquids and tissues. Cell death from membrane disruption can occur even at relatively low acoustic intensities.

Exposure to ultrasonically vibrating solids, such as an acoustic horn, can lead to rapid frictional heating and potentially severe burns.

### 6. Centrifuges

Centrifuges must be properly installed according to manufacturer recommendations. It is important that the load is balanced each time the centrifuge is used and that the lid is closed while the rotor is in motion. The disconnect switch must be working properly to shut off the equipment when the top is opened, and the manufacturer's instructions for safe operating speeds must be followed.

For flammable and/or hazardous materials, ensure the centrifuge is under negative pressure and connected to a suitable exhaust system.

### 7. Rotary Evaporators

Glass components of the rotary evaporator should be made of Pyrex or similar glass. Glass vessels should be completely enclosed in a shield (i.e., tape, mesh or plastic coating) to guard against flying glass if the components implode. Increase in rotation speed and application of vacuum to the flask whose solvent is to be evaporated should be gradual.

When not located in a fume hood or ventilated enclosure, rotary evaporators may require blast protection, spill control and local exhaust ventilation (per NFPA 45 annex C). Refer to section 9 on Vacuum Systems for requirements on rotary evaporator vapor cold traps.

### 8. Autoclaves

Personnel using autoclaves are required to receive training on the use of the autoclave and on the safety measures prior to operating an autoclave. The EH&S General Autoclave Safety Guidelines are required to be reviewed by any person that operates an autoclave for any reason.

### 9. Vacuum Systems

Vacuum pumps are used in labs to remove air and other vapors from a vessel or manifold. The most common usages are on rotary evaporators, drying manifolds, centrifugal concentrators, acrylamide gel dryers, freeze dryers, vacuum ovens, tissue culture filter flasks and aspirators, desiccators, filtration apparatus and filter/degassing apparatus.

Weak points in containers or systems under vacuum can create implosion or explosion hazards, and cause injury by violently spraying glass and hazardous materials. Conduct all vacuum operations behind a table shield or in a fume hood. All glass containers must be strong enough to handle the pressure differential without failure. If the apparatus or glass lines are chipped or cracked, the container must be replaced immediately. Wrap glass vessels with tape, mesh or plastic coating and enclose the vacuum trap inside a rigid container.

If a stand-alone vacuum pump is used with volatile hazardous materials, it is important to trap the vapors so that they do not degrade the pump oil or pass through the pump and get emitted in the exhaust. The trapping device may be a cold trap cooled with dry ice or liquid nitrogen, but the trap type depends on the specific chemicals that need to be trapped. Stand-alone vacuum pumps should exhaust to a fume hood or other building exhaust; they should not exhaust into the room. This is essential when the pump is being used to evacuate a system containing a volatile toxic or volatile corrosive substance. Scrubbing or absorbing the gases exiting the pump is also recommended.

Other practices to ensure safe conditions when working with vacuum systems include the following:

**a. Pumps**

- Ensure that mechanical pumps have belt guards in place.
- Ensure that service cords and switches are free from defects.
- Always use a trap on vacuum lines to prevent liquids from being drawn into the pump, house vacuum line, or water drain.
- Replace and properly dispose of vacuum pump oil that is contaminated with condensate. Used pump oil must be disposed of as hazardous waste.
- Place a pan under pumps to catch oil drips.
- Do not operate pumps near containers of flammable chemicals or materials.
- Do not place pumps in an enclosed, unventilated cabinet.

**b. Glassware**

- Use only heavy-walled round-bottomed glassware or glassware specifically designed for vacuum systems.
- Carefully inspect vacuum glassware before and after each use. Discard any glass that is chipped, scratched, broken or otherwise stressed.

**c. Cold trap**

- Locate the cold trap between the system and vacuum pump.
- Ensure thatthe cold trap is of sufficient size and cold enough to condense vapors present in the system.
- Check frequently for blockages in the cold trap.

### 10. Equipment maintenance

Proper use and maintenance of laboratory equipment can protect the safety of both the personnel and the equipment in use. Certain equipment found within labs may warrant greater attention than others depending on the specific hazards present. Define and document routine maintenance requirements and frequency for laboratory equipment. It is the responsibility of every lab member to refer to the user operating manual of specific lab equipment to determine appropriate routine equipment maintenance of the equipment.

## G. DECONTAMINATION OF WORK AREAS

Laboratory personnel are responsible for providing a clean and unobstructed work area for all maintenance and service personnel. Floors should be cleaned regularly and kept free of obstructions.

### 1. Custodial Services

UW Custodial Services will clean floors in laboratories only if requested. Contact Custodial Services at 206.685.1500 on the Seattle campus; (refer to Appendix F) for contact numbers for Facilities Services at other locations. Custodial floor care equipment should not be used to clean up spills or chemical residue.

### 2. Servicing of Lab Area or Equipment

If facility personnel need to service an area or equipment, ensure the area/equipment is unobstructed, emptied of chemicals, decontaminated, washed with warm, soapy water, and rinsed. This requirement applies to fume hoods; in addition to cleaning, the fume hood should be cleared out of all chemicals, glassware, and equipment prior to servicing. The area or equipment must have a posted Notice of Laboratory Equipment Decontamination Form before service will be provided.

Facilities Services and maintenance personnel will refuse the work if the area or equipment has not been decontaminated and/or cleaned. Personnel look for visible debris, absorbent pads or papers taped to surfaces, and visible or sticky spilled materials when determining if the area or equipment is clean.

If laboratory personnel may not be present when service personnel are scheduled to arrive, leave a note stating a contact name and phone number in case there are questions about the work.

## H. DECONTAMINATION OF EQUIPMENT FOR DISPOSAL

All laboratory equipment *must* be assessed by the user for hazardous materials prior to being sent to UW surplus. A laboratory employee knowledgeable of the hazardous materials used in the laboratory and/or equipment must prepare the equipment according to the decontamination and cleaning instructions and verify that the equipment is safe to handle by UW Facilities or contractors without the use of personal protective equipment. *The releasing party retains full responsibility for ensuring the item is* cleaned and decontaminated prior to pick up or delivery to the UW Surplus Property warehouse.

Equipment must be cleaned inside and out of all visible residue and encrusted material. All equipment and furniture must be emptied, and all locks must be unlocked, including cabinets and drawers. Labels, signage, and hazard warnings (e.g., universal biohazard symbol) must be removed or defaced. All laboratory tubing must be removed from the equipment. A Notice of Laboratory Equipment Decontamination Form must be completed and affixed to the item. UW Moving & Surplus has the right to *refuse any* equipment and materials if the above decontamination and cleaning steps have not been properly followed. Examples of equipment that must be decontaminated include centrifuges, incubators, cryostats, ovens, BSCs, refrigerators, freezers, sinks, storage cabinets, lockers, bins and tanks. (Tanks have the potential to be a confined space hazard and require special procedures. Call EH&S at 206.543.7388.)

Any equipment capable of generating radiation or containing radioactive sources must be checked by the EH&S Radiation Safety Office prior to public sale. After the equipment has been checked and cleared, Radiation Safety posts the Radiation Safety Clearance Form. Examples of these items are provided below.

- Gas chromatographs equipped with an electron capture detector (ECD).
- Lasers (Class 3B and Class 4 only).
- Liquid Scintillation Counters (LSC).
- X-ray equipment.
- Any item with a "Caution –Radioactive Material" sticker or radioactive emblem.

Please refer to the Preparing Radiation Items for Surplus Guideline. Please contact the Radiation Safety Office at 206.543.0463.

The following items *CANNOT* be accepted by Surplus Property. Contact EH&S EP at 206.616.5835 for information on how to dispose of these items:

- All chemicals and cleaning products: Fill out the EH&S chemical waste pick-up form for disposal.
- All food and liquids.
- All sharps: syringes with needles, syringes without needles, lancets, scalpel blades, razor blades, broken glass, and fragile glass items such as pasteur pipettes, slides and coverslips. Contact EH&S's Biosafety at 206.221.7770 / ehsbio@uw.edu for assistance.
- Capacitors and transformers. Some equipment may contain transformers, such as x-ray equipment and electron microscopes; these transformers may be accepted but must be drained of oil and the oil must have been tested and certified as being non-PCB by EH&S's Chemical Waste group at 206.616.5835 / chmwaste@uw.edu.
- Gas cylinders, pressurized containers/vessels. Refer to EH&S's Compressed Gas webpage for assistance.
- X-ray film and x-ray plates. Contact EH&S EP at 206.616.5835 / chmwaste@uw.edu for assistance and disposal instructions.
- Radiation detection equipment. Contact the Radiation Safety Office at 206.543.0463 for assistance.
- Instruments containing mercury (temperature or pressure measurement devices, coulter counters, silver-tipped thermometers/thermostats). Contact EH&S's Chemical Waste group 206.616.5835 / chmwaste@uw.edu for assistance.
- Materials containing asbestos, including but not limited to: autoclaves, laboratory ovens, older furnaces, fire-proof file cabinets, and anything that produces high heat. For assistance, contact the Facilities Regulated Materials office by submitting a request.
- All paint. For disposal follow these paint disposal guidelines.
- Ice Packs. Ice packs may be thrown away. Contact UW Recycle with further questions on ice pack disposal.
- All safety cans: faucet, bench, plunger, daub, biohazard and oily waste. Refer to EH&S's website for assistance.
- All drums, barrels, totes and containers used for safe storage: lab pack, overpack and salvage. Refer to EH&S's website for assistance.
- Glassware that is broken, cracked, chipped and/or has visible residue and encrusted material. Contact EH&S's Biosafety at 206.221.7770 / ehsbio@uw.edu for assistance.
- All laboratory plasticware, including but not limited to bottles, jars, jugs, carboys, flasks, caps, stoppers, droppers, funnels, graduated cylinders, spatulas, rods, tubes, racks,

microplates, pipette tips, etc.

- All plastic and rubber laboratory tubing. Refer to EH&S's website for assistance.

For more information about surplusing property, such as conditionally accepted items, preparing items for Surplus, and surplusing equipment on federal awards, please visit the Surplus website.

### 1. Equipment Used to Process/Store Chemicals

Safely remove or drain chemicals from the equipment, including any oil or coolant. Collect the chemical(s) for reuse or dispose of as hazardous waste. If applicable, use an inert gas or liquid to purge or rinse out chemical residues. In some cases, rinseate will need to be disposed of as hazardous waste as well. Refer the Chemical Waste webpage or call EH&S Environmental Programs at 206.616.5835 for questions regarding hazardous waste, disposal of chemicals and/or rinseate.

Decontaminate the equipment as necessary. For example, use solvents to remove viscous or non-water-soluble contaminants. Then scrub decontaminated equipment thoroughly with warm, soapy water. Rinse and dry. Wash and/or rinse water and solvents may need to be managed as hazardous waste. Contact EH&S at 206.543.7388 for more specific information about decontamination.

### 2. Equipment Used to Process/Store Radionuclides

Conduct a thorough radiation survey of all accessible surfaces of the equipment with an appropriate instrument. If you detect radioactive contamination, clean surface to background by:

- Wetting paper towels with a decontamination solution (i.e., liquid detergent, commercial decontamination solution, 409™, Simple Green™, Scrubbing Bubbles™, etc
- Wiping the contaminated surface from the outer edge inward
- Discarding the used paper towels into an appropriate radioactive waste container after each pass
- Surveying the paper towel with the appropriate meter to determine if contamination was removed (picked up)

Repeating the steps above until the paper towels are no longer picking up removable contamination.

Resurvey to assure that contamination is less than 100 counts per minute per 100 square centimeters of surface. If contamination persists or you have other questions, contact the EH&S Radiation Safety at 206.543.0463.

### 3. Equipment Used to Process/Store Biological Material

Remove all biological material from the equipment. Decontaminate with a 1:10 bleach solution. After 30 minutes of contact time, rinse metal surfaces. If you have specific biosafety questions, contact EH&S Research and Occupational Safety at 206.221.7770.

Before repair or relocation, biosafety cabinets (BSCs) must be decontaminated by EH&S or by a contractor approved by EH&S. For this service, contact EH&S at 206.685.3993.

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# SECTION 5 - EMPLOYEE HEALTH AND PPE

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# A. ENVIRONMENTAL MONITORING AND MEDICAL SURVEILLANCE

As a general principle, exposure to hazardous chemicals should be kept as low as possible and avoided when possible through good laboratory procedures. If there is reason to believe that exposure to a chemical exceeds a permissible exposure limit for a chemical, then the RP or supervisor is required to arrange for an evaluation to evaluate and/or measure an employee's exposure to that chemical. This is arranged by contacting EH&S at 206.543.7388.

Personnel working in shared spaces may be exposed to hazardous chemicals in use by parties under the supervision of a RP. Proper management of hazards and good laboratory procedures are a shared responsibility for all parties using the space.

## 1. Exposure Limits

Exposure limits can be defined by a regulation identified as a Permissible Exposure Limit (PEL) or by a guideline. PELs are listed in the Washington Administrative Code WAC 296-841-20025. Some chemical-specific regulations set a limit called an Action Level (AL) in addition to the PEL. If an AL is exceeded, continuing actions must be taken to make sure the levels do not exceed the PEL.

There are approx. 600 chemicals with a regulatory PEL, so it is frequently necessary to refer to a guideline to get an idea of a possible significant exposure. Guideline limits are considered recommendations and exposures should not exceed these levels. These guidelines are typically more up to date than the regulatory limits. Various organizations publish guidelines, as shown in Table 5-1, Guidelines for Airborne Exposure Levels.

***Table 5-1 Guidelines for Airborne Exposure Levels***

| Guideline organization | Guideline title |
|---|---|
| National Institute for Occupational Safety and Health (NIOSH) | Recommended Exposure Limits (RELs) |
| American Conference of Governmental Industrial Hygienists (ACGIH) | Threshold Limit Values (TLVs) |
| American Industrial Hygiene Association (AIHA) | Workplace Environmental Exposure Limit Guides (WEEL Guides) |

In addition to the organizations listed above, guidelines may also be produced by other organizations, nations, and chemical manufacturers. The recommended limits can be obtained from the publications of those organizations, found on Web pages, or sometimes listed on safety data sheets. Contact EH&S at 206.543.7388 concerning exposure limit questions. Due to lack of complete knowledge of the health effects of chemicals and possible chemical synergies, there may be an exposure issue even though levels do not exceed limits. Personnel should take reasonable steps to reduce exposures and keep levels as low as feasible.

## 2. Special Chemical Air Monitoring

Washington State L&I regulations specifically address the chemicals listed in Table 5-2, Special Chemical Air Monitoring, and require that air monitoring be done. In most cases, EH&S can perform air monitoring. Contact EH&S at 206.543.7388 for assistance if you routinely use any of these chemicals in Table 5-2:

***Table 5-2 Special Chemical Air Monitoring***

| **Chemicals Requiring Air Monitoring** | | |
|---|---|---|
| Acrylonitrile | 1,2-Dibromo-3-chloropropane | Methylene chloride (aka. Dichloromethane) |
| Asbestos | Ethylene oxide | 4,4'-Methylene-dianiline |
| Benzene | Formaldehyde | Thiram |
| 1,3-Butadiene | Inorganic Arsenic | Vinyl chloride |
| Cadmium | Lead | |

### 3. Possible Over-Exposure

Exposures exceeding recommended limits are considered over-exposures. Such limits apply to airborne levels which may result from operations that generate air contaminants outside of fume hoods, from a spill of a volatile chemical, or a leak of a gas. Other routes of entry into the body besides inhalation – ingestion, direct skin or eye contact with a chemical, injection under the skin by a sharp object or high- pressure source, or a combination of these routes – may also present a significant exposure. These exposures may occur if safe practices are not followed. In some cases, workers may show signs of exposure such as headaches, rashes, nausea, coughing, tearing, irritation or redness of eyes, irritation of nose or throat, dizziness, and loss of motor dexterity or judgment. Such conditions should be evaluated if there is no pathological cause for such symptoms. Follow-up is especially important if the symptoms disappear when the person leaves the exposure area and then reappear soon after the employee returns to work, or if two or more people in the same laboratory work area have similar complaints. For specific exposure response procedures, refer to the Exposure Response poster.

### 4. Medical Evaluations

Laboratory employees who were monitored and found to exceed recommended limits, or suspect they may have been over-exposed (such as during a spill clean-up), or have been advised by their private practitioners that they may be impacted by workplace chemical exposures, or are having symptoms consistent with over-exposure to a chemical, should contact the Campus Employee Health Center (206.685.1026 for most work areas; 206.744.3081 for HMC employees; 206.598.4848 for UWMC employees). The occupational health nurse will coordinate medical consultation, exams, and surveillance.

**Personnel involved in any emergency situation should go directly to the nearest emergency room or call 911 (on campus) for assistance, depending on the situation.**

Use the Exposure Response poster for responding to a biological, chemical or radiological exposure.

## B. PERSONAL PROTECTIVE EQUIPMENT (PPE)

The purpose of PPE is to reduce student, employee, and visitor exposure to laboratory hazards. Examples of PPE include gloves, eye and foot protection, respirators, and protective clothing such as aprons and lab coats. (Refer to Table 5-3 for example PPE by hazard type). EH&S recommends that lab coats and eye protection *always* be worn when working in the laboratory as best practice.

The RP or laboratory managers are required to assess the hazards and risks of exposure based on the procedures performed in the laboratory and the controls in use. The PI or manager may consult

the laboratory PPE Hazard Assessment Guide.

Before work is initiated, refer to a copy of the completed assessment or other documents detailing the lab PPE requirements such as standard operating procedures (SOPs). If PPE is required, the responsible party or their department must provide PPE at no cost to an employee (except for prescription safety glasses and closed shoes) in accordance with APS 10.04. The PI or lab manager must also instruct employees in how to select, inspect, use, maintain, and store the PPE. PPE training records should be maintained (as described in Section 8 of this manual).

Although students must be protected to the same degree as employees, they may be liable for purchase of their own PPE, such as safety goggles or respirators. Some commonly used PPE, such as aprons, can be purchased and made available for student use by the department.

***Table 5-3 Hazards and Example PPE***

| Hazard | Personal protective equipment |
|---|---|
| Biohazards | Gloves, lab coats, liquid resistant surgical masks, aprons, sleeve covers, face shields, splash goggles |
| Chemicals | Gloves, chemical-resistant lab coats, clothing, or aprons, sleeves and shoe covers, vapor-proof or splash goggles; lab coats and gloves for general use |
| Cuts/Abrasions | Cut-resistant gloves (leather, Kevlar, chainmail) |
| Dust | Dust goggles, respirators |
| Electricity | Electrically resistive gloves, mats, hard hats |
| Explosions | Protective vests, face shields |
| Falling Objects | Hard hats, steel-toe shoes, metatarsal guards |
| Falls | Fall harness, strap-on hard hat |
| Fires | Fire-resistant lab coat |
| Flying Particles | Safety glasses w/ side shields, goggles, face shields |
| Hot Environments | Cooling vests, reflective suits |
| Hot or Cold Objects | Thermal gloves (Note: Asbestos gloves are prohibited and must be turned in as hazardous waste.) |
| Intense Light | Opaque glasses, goggles, welding hoods |
| Kneeling | Knee pads |
| Lifting | No PPE available, use engineering controls/training |
| Low Overhead Objects | Bump cap, hard hat |
| Noise | Hearing protection devices |
| Over-Water Work | Life vests, flotation devices |
| Radiation | Lead apron, lead gloves, thyroid collar, lead glasses for X-ray, lab coats/gloves for radioactive materials |
| Repetitive Motion | No PPE available, use engineering controls/training |

| Hazard | Personal protective equipment |
|---|---|
| Slipping | Non-skid shoes |
| Splashes | Splash goggles, face shields, chemical-resistant clothing, gloves, aprons,<br>sleeves and shoe covers |
| Traffic | Reflective vest |

## 1. Eye Protection

Appropriate eye protection must be worn when working with chemicals. EH&S recommends that eye protection always be worn when working in the laboratory, as best practice, due to potential accidents affecting individuals away from the scene. Avoid use of contact lenses in the laboratory. If you wear contact lenses, notify the PI or laboratory supervisor, and always wear chemical splash goggles or a face shield.

### a. Prescription Safety Glasses

Prescription safety glasses are available from optical stores or vendors on UW Procurement Services. Do not use regular glasses as safety glasses; they are not strong enough.

### b. Safety Glasses

Safety glasses with side-shields are designed to provide impact protection but provide little protection from chemical splashes, dusts, or hot particles.

### c. Splash Goggles

Wear splash goggles with splash-proof sides when there is a danger of a chemical splashing. Goggles that have screened sides or other vents are not splash proof, but they can be worn when working with apparatus that could produce flying particles (e.g., glassware under reduced or elevated pressure).

### d. Face Shields

Face shields, in addition to safety glasses or splash goggles, provide maximum protection to the face and neck from flying particles and harmful liquids. Face shields also may be needed when a vacuum system is used.

### e. Free-Standing Barrier Shields

Free-Standing barrier shields can be used to protect yourself and bystanders from possible explosion.

### f. Specialized Eye Protection

Specialized eye protection is needed when working with lasers, ultraviolet light, infrared light, or intense visible light, such as during glassblowing and welding work. Glasses, goggles, or face shields with adequate filtration are needed. For assistance, contact EH&S Radiation Safety at radsaf@uw.edu or 206.543.0463.

## 2. Personal Apparel

### a. Appropriate Clothing

The clothes you wear in the laboratory are an important consideration for personal safety and can influence the severity of consequences of spills, splashes, and burns. If the lab has any hazardous materials or hazardous procedures performed in the room, the expectation is that lab members wear lab coats for all work.

These guidelines should be followed when working in the laboratory:

- Shoes should fully cover the feet to protect against spills; no open-toed shoes or sandals are permitted, and shoes constructed of mesh (such as athletic shoes) are not recommended.
- The core body should be covered, so clothing items like crop tops should not be allowed.
- Clothing should fully cover your legs.
- Materials you wear in the laboratory can make a difference. Many synthetic fabrics may be dissolved by solvents or may melt into your skin, causing more extensive burns if they catch on fire. Preferred materials are cotton, wool, and resistant polyester. Synthetic materials, such as acrylics, rayon, and polyester are not recommended.
- Loose, flowing garments and scarves should be avoided; they may easily pick up spills or trail through a burner flame.

**b. Jewelry and accessories**

Loose jewelry such as bracelets, watches and necklaces should be avoided since they may catch on equipment. Avoid rings that can damage protective gloves or make removing gloves difficult.

Items such as headphones or earbuds that can impede hearing should be avoided since they may reduce awareness of hazards or incidents occurring in the workspace.

**c. Synthetic nails**

Synthetic and acrylic nails are not recommended for certain types of laboratory work as they can pose a potential burn hazard depending on the chemicals or equipment being used. Acrylic nails are very flammable and, once ignited, they burn to completion. Also ensure that synthetic nails do not damage protective gloves or make removing gloves difficult.

**d. Hair**

Tie back long hair so it does not get caught in equipment, come in contact with chemicals, or interfere with your field of view.

**e. Laboratory Coats**

Laboratory coats are personal protective equipment (PPE) and protect the skin and clothing from splatter and spills. Laboratory coats are a critical component to worker protection in laboratory areas. All students, faculty, staff, and visitors who conduct work activities with hazardous chemicals, biohazards and radiological hazards must be provided with (and wear) a laboratory coat.

Laboratory personnel should wear lab coats or aprons and sleeves whenever there is a potential for contaminating skin or clothing. Laboratory coats that extend to the knee are required and should be buttoned completely in order to protect skin and clothing from splatter and spills. Lab coats are loose-fitting by design so that it is faster and easier to remove than street clothes, therefore minimizing skin contact with hazardous materials. There are several types of lab coats which provide varying degrees of protection. A few examples of the different protection available include splash-resistant coats, static-free coats, chemical-resistant coats, and flame-resistant lab coats. Please make sure that the coat you wear provides the type of protection that is appropriate for the task and activities performed.

Flame-resistant lab coats are recommended when working with highly flammable, pyrophoric, or potentially explosive chemicals.

Lab coats and other protective wear used in a lab should be kept in the work area to minimize the possibility of spreading chemicals to public places (including eating or office areas). Contaminated personal clothing may spread hazards to family and friends, as well as contaminate public areas such as doors, hallways, elevators, and food services.

**f. Laboratory Laundry Requirements**:

- Laboratory coats must be laundered when soiled (or potentially soiled) on a determined schedule to help ensure they are washed regularly. Labs should determine a laundering schedule based on the work activities and frequency of use.
- Laboratory coats may not be taken home to be cleaned in a domestic washer, nor should they be taken to a laundry service that is not equipped to handle contaminated items.
- Laboratory coats should be laundered through a UW contracted vendor.
- If any aspect of your work includes biohazardous agents, you are required to use a laundry vendor that can provide medical laundry service. Medical laundering uses cycles of chemicals, heat, and mechanical agitation to ensure biohazards are adequately removed. Medical laundering removes most vegetative pathogens but does not make the coats sterile. More information on requirements for medical laundry are available from the Centers for Disease Control and Prevention (CDC).

## 3. Gloves

### a. When to Wear Gloves

Wear gloves whenever working with chemicals, biohazards, radioactive materials, rough or sharp-edged objects or very hot or very cold materials. Wear the right size glove. After researching that a glove provides adequate chemical protection, the gloves should be tested while performing the lab procedure to ensure the glove provides enough dexterity to perform the work safely; if a glove is too slippery to allow gripping, a different type of glove can be worn over the chemical protective glove to improve dexterity.

### b. When to not wear Gloves

Do not wear gloves around an unguarded, moving machine as it could snag the glove and pull your hand into it.

Do not wear gloves when touching common surfaces such as telephones, computers, doorknobs, elevator buttons or objects that may be touched without gloves by others.

Do not wear gloves outside the laboratory.

### c. Selection

Select gloves based on the material being handled, the hazard involved, and their suitability for the procedures being conducted (such as whether the glove provides appropriate dexterity for the procedures). Gloves appropriate for a specific task or usage with certain hazardous chemicals should be documented in the SOP for that work.

To select the appropriate chemical-protective glove, read the SDS, review guidance from glove manufacturers, or consult EH&S at 206.543.7388. Thin, disposable gloves should not be expected to

provide long-term protection from immersion in a chemical; use thick gloves if immersing hands in a chemical.
Other types of gloves used in a laboratory may be designed to protect from biological hazards, sharp objects, and temperature extremes, among other hazards. Asbestos gloves are prohibited, and any found in a laboratory should be turned in as hazardous waste.

#### d. Inspection

Inspect gloves before each use and discard if there is discoloration, punctures, or tears. Do not blow into gloves to check for integrity. If there is no external contamination; the glove can be squeezed to determine if the trapped air is escaping through small holes.

#### e. Removal

Take off gloves before leaving the laboratory. If using reusable gloves, wash them with soap and water before removing them to get rid of possible contaminants. Get in the habit of removing gloves without touching the outside of the glove to clothing or skin. Wash hands with soap and warm water after removing gloves.

#### f. Replacement

Replace gloves often, depending on their frequency of use and permeability of the chemical(s) handled. Do not reuse disposable gloves.

#### g. Contaminated Gloves

Dispose of contaminated gloves by carefully removing them and placing them in a plastic bag. If they are grossly contaminated with hazardous chemicals, then manage them as hazardous waste. For more information, refer to www.ehs.washington.edu/chemical/hazardous-chemical-waste-disposal.

#### h. Latex Gloves

Do not wear latex gloves in the lab for chemical protection. They provide very little protection from chemicals. Latex gloves can be the source of allergic reactions, which can range from powder abrasion dermatitis to a life-threatening hypersensitivity to the latex protein. Latex gloves are not permitted in any lab that is affiliated with clinical services.

### 4. Respirators

Respirators should not be needed in a normal laboratory setting. However, if you suspect laboratory airborne hazardous chemical concentration is near the PEL, contact EH&S at 206.543.7388 for a consultation.
All use of respirators at the University must comply with the UW Respiratory Protection Program prior to first use. For more information, contact EH&S at 206.543.7388 and refer to the Respiratory Protection Program web page. This program includes evaluating hazards and medical fitness of each user, training, selecting equipment and understanding its limits, fit testing, and annual recertification.

### 5. Hearing Protection

Hearing protection (earplugs or earmuffs) may be needed for some procedures or in some laboratory settings as a part of the UW Hearing Loss Prevention Program. Do not use headphones or earbuds underneath hearing protectors. If you suspect the noise levels may be potentially harmful, contact EH&S at 206.543.7388 for an evaluation. (As a rule, if you are in a noisy environment where you have to raise your voice to be intelligible to someone standing next to you for most of the day, the noise levels may be potentially hazardous.)

### 6. PPE: Outside the Laboratory

It is standard practice to remove all PPE, including gloves and lab coats, prior to exiting the laboratory. This prevents any possible contamination of clean areas such as restrooms, elevators, offices and cafeterias. When you wear gloves or a lab coat in the hallway, the general public perception is that you have been handling something that is possibly harmful to humans. Furthermore, if you have been working with or handling potentially harmful materials, your gloves or lab coat may be contaminated, and you may not know it.

It is also critical to remove all PPE, including gloves and lab coats, when leaving areas where any hazardous materials, which may have contaminated the PPE, are in use. This includes hazardous chemicals, radioactive materials, nanoparticles, or other hazardous materials. When transporting hazardous materials through common hallways, the outer surface of the container must be free from contamination. This minimizes potential contact with any hazardous material, thus eliminating your need to wear gloves or a lab coat outside of the laboratory.

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# SECTION 6 - STANDARD OPERATING PROCEDURES

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## A. STANDARD OPERATING PROCEDURES (SOPS)

Laboratories must provide personnel with standard operating procedures (SOPs) to be followed when working with hazardous materials. This applies to all hazardous materials (including all hazardous chemicals) in use. Materials not in use should be administratively managed to remind all lab personnel that an SOP needs to be developed prior to use. The SOPs must address all requirements to perform the laboratory procedures safely. The requirements may either be given in a cover sheet (described below) attached to the laboratory protocol(s) or be integrated into a protocol.

Developing SOPs is also addressed in the EH&S *Laboratory Safety Practices* class, which is required for a laboratory's RP, CHO, and any laboratory supervisors/managers. Registration for this class is available through the EH&S website or call EH&S at 206.543.7201 for more information. For advice in developing SOPs, call EH&S at 206.685.3993 or email .

SOPs obtained from other organizations and SOPs written in the form of step-by-step procedures can be used as long as all the basic components are addressed, information is edited to be UW- and location-specific, and the SOP accurately describes your laboratory's safety requirements. If SOPs are provided by outside sources (such as equipment suppliers or another laboratory) or modified from a template, they must be carefully reviewed to ensure they describe your protective measures accurately, including describing specific types of PPE and control equipment you will use.

Feel free to attach additional information, such as Safety Data Sheets (SDSs) to your SOP. Chemical-specific hazard information is available in the appendices of certain regulations (such as for arsenic and lead), the EH&S Web pages, other websites, and reference books.

## B. SOP COMPONENTS

SOP Templates are available in Appendix D and on the EH&S website's Chemical SOPs webpage.

Review all required safety elements for SOPs. Descriptions of each element using a typical SOP design are listed in this section.

If a particularly hazardous substance is involved in the process, expanded requirements must be addressed. Particularly hazardous substances include substances that are extremely dangerous or toxic, are recognized carcinogens, or are reproductive hazards. More information about particularly hazardous substances is available on the EH&S website.

### 1. Process Identification

Identify the name of the process. This could include the chemicals or equipment involved to differentiate the SOP from similar processes.

### 2. Chemicals and Hazards

Identify the stock chemicals, intermediates, final compounds, wastes involved and such factors as use of catalysts or inert compounds that the SOP applies to. List the hazards, including physical hazards such as heat, cold and varied operating pressures, which are involved in the process.

### 3. Personal Protective Equipment (PPE)

PPE includes gloves, lab coats, etc., and is the minimal method of protection if alternatives are not available. However, when PPE is required, it must be specified completely, such as the type of glove to be used and whether it is necessary for the entire process or at certain steps.

A laboratory PPE Hazard Assessment Guide is available on the EH&S website and PPE is described in this manual, Section 5.b, Personal Protective Equipment (PPE) Environmental /

Ventilation Controls. Specific PPE used in addition to that documented in the lab's PPE Hazard Assessment should be specified in the SOP for that work.

### 4. Environmental/Ventilation Controls

Describe engineering controls to be used to minimize exposures, including fume hood, glove box, snorkel, or local exhaust ventilation systems. Describe ways to verify that the fume hood and other control system(s) are operating correctly before using hazardous chemicals.

Provide additional details if particularly hazardous substances (highly toxic or dangerous chemicals, carcinogens, reproductive toxicants or select toxins) are used. These details should address using specific containment device(s), such as fume hoods or glove boxes. For definitions and criteria of particularly hazardous substances, refer to the EH&S website.

### 5. Special Handling Procedures & Storage Requirements

Describe administrative controls, such as transportation in secondary containment within or outside the laboratory space and purchase of pre-formulated liquids instead of powders to be weighed and prepared. If not specified in general laboratory rules, identify procedures such as keeping the fume hood sash as low as possible, hygiene practices (such as hand washing), and procedures for removal and disposal of contaminated PPE. Identify best practices that can be used to minimize accidents, such as placing temporary hazard signs, when personnel may be absent.

Specify if there are limits to the amount of reactants used during the process. This also provides guidance for chemical purchases (e.g., purchase the smallest quantity necessary whenever possible). Describe storage requirements, such as the use of secondary containment or storage in locked cabinets, and lab-specific storage locations.

### 6. Spill and Accident Procedures

Describe how spills or accidental releases should be handled and by whom (e.g., a spill of 100 ml in a fume hood may be easily handled by personnel, but a spill of 10 ml outside the hood may not be safely handled).

### 7. Waste Disposal

Describe waste disposal procedures for all waste produced. Be aware that many laboratory accidents happen from inadvertent disposal of incompatible wastes into the same waste container, so ensure that different waste streams are identified where appropriate.

Include describing procedures to neutralize or treat waste to make handling safer or to reduce the amount of hazardous waste. EH&S has preferred treatment options concerning waste minimization on the EH&S website.

### 8. Special Precautions for Animal Use

Annotate "N/A" if no animal exposure is involved. If chemicals are being administered to animals, describe how employees should protect themselves from contaminated animals and animal waste. Include information about restricted access, administration of the chemical, aerosol suppression, protective equipment, and waste disposal.

### 9. Approval Required

Describe any requirements for obtaining authorization before the procedure, operation or activity can be performed (e.g., personnel must have training documented before performing a certain procedure for the first time). Other required authorizations could include completing a medical examination before using a respirator when performing procedures involving certain hazardous

substances (e.g., lead dust, pathological organisms). Authorizations are required before a person can independently perform a process using a particularly hazardous substance. Maintainwritten documentation with the SOP.

### 10. Decontamination

Describe decontamination procedures, including chemical decontaminant handling, for equipment meant to be reused.

### 11. Designated Area

Identify where the particularly hazardous chemicals may be used.

## C. EXAMPLE SOPS

Templates for SOPs are available on the Chemical SOPs webpage. If used by your laboratory, these documents must be modified and customized to make them specific to your laboratory conditions. If your laboratory generates an SOP and would like to make it available to other labs, please attach an electronic copy to an email addressed to labcheck@uw.edu.

## D. STEPS TO DEVELOP YOUR SOPS

To develop your laboratory SOPs, EH&S suggests the following steps:

### 1. Step 1 – Modify Existing SOPs

### 2. Step 2 – Identify Requirements

EH&S recommends you review and modify any generic SOPs that pertain to your laboratory to be UW- and location-specific for your laboratory.

Identify if any particularly hazardous substances are in use in your laboratory, and identify which way of writing your SOPs will best cover your laboratory's chemicals or processes.

SOPs can be written in one or more of the following ways:

#### a. By Process

By process, such as distillation, peptide synthesis or gel electrophoresis. Safety requirements could be noted either by integrating them into the steps in the process or by using a cover sheet of safety requirements for that specific process. If hazardous intermediates are created, carefully consider if there are specific precautions which should be noted, such as how to tell if a release or spill occurs, what symptoms may develop if a person is exposed and any special precautions for spill clean-up and waste disposal.

#### b. By Individual Chemical

By each individual chemical, such as acrylamide, formaldehyde, or toluene. This approach may be most useful if a limited number of hazardous substances are used in the laboratory, if there are specific regulatory requirements for a chemical, if the chemical is extremely reactive or incompatible with other chemicals, or if using a particularly hazardous substance.

#### c. By Class of Chemical

By class of chemicals, such as mineral acids, organic solvents or peroxidizable chemicals. This approach may be most useful if multiple procedures are performed using similar substances. Note that not all chemicals in the same class are compatible with each other, and incompatibilities should be addressed by the SOP. Avoid listing the same chemical on multiple chemical class SOPs to ensure specific practices are clear and followed for that chemical. For the same reasons, a chemical that already has its own

individual SOP should not also be listed on a chemical class SOP.

### 3. Step 3 – Complete the SOPs

After modifying generic SOPs and identifying which ways of writing are most useful in your situation, continue by developing SOPs for processes, chemicals, and chemical classes not previously written to ensure all hazardous materials in use are covered. Ensure all components of the SOPs are addressed if the SOP pertains to chemicals considered particularly hazardous (those that have a high degree of acute toxicity, those that are especially dangerous or are select carcinogens or reproductive toxins, such as those listed as particularly hazardous substances and similar substances). The RP/CHO must sign and date to approve the SOP. Electronic signature is acceptable for SOPs stored electronically.

### 4. Step 4 – File the SOPs

After completing the SOPs, file the master copies in hardcopy or electronically so that everyone can find and access them. If they are not physically filed in the laboratory-specific information section of your CHP, the laboratory-specific information pages should be annotated to identify where the SOPs are physically or electronically located. They must be accessible in the space where the hazardous chemicals are used.

### 5. Step 5 – Train on use of the SOPs

All laboratory personnel must be trained by the RP, laboratory manager, CHO, or supervisor prior to using the process/chemical in the laboratory. Documentation of training must be maintained and available for review. The SOP training form in Appendix B may be used, or the laboratory may choose to create their own form. Documentation may be electronic or hard copy.

### 6. Step 6 - Distribute Copies of the SOPs

If you provide working copies of your SOPs to your personnel, keep track of how many copies you make and distribute. If there is a central electronic location, track who has access to the files. When you make changes, you will need to ensure that the updated SOPs reach all those who perform the procedures.

If you develop an SOP you believe can be used by other departments in the University, please forward a copy electronically to the UW CHO at labcheck@uw.edu.

### 7. Step 7 - Update SOPs as Needed

If you note changes to your process or chemical use that impact an SOP, or recognize improvements that can be made, update it as soon as possible. Sign and note the revision date on the SOP.

Notify all lab personnel of the revised SOP, and document training. Replace the previous SOP in your files and anywhere else they may have been placed, including those that may be kept at the lab benches or in individual personnel members' files.

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# SECTION 7 - SAFETY TRAINING

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## A. SAFETY TRAINING REQUIREMENTS

According to federal, state, local, and UW policy, RPs and laboratory supervisors are responsible for ensuring that all employees receive adequate training in order to understand the hazards and safety measures in their work area. Training must be documented and occur prior to assignments involving new hazards. Refresher training or retraining may be required by law and for personnel who demonstrate they did not understand the initial training or are not following required procedures.

Each laboratory must have a method for tracking the training new employees receive before working with hazardous chemicals and other hazards in the laboratory. All visitors must receive sufficient training to ensure they are also aware of the hazards and how to protect themselves while in the work area. Refer to section 1 for additional details on these requirements.

Personnel safety training is essential for preventing laboratory injuries, illnesses, and incidents. EH&S has developed a matrix describing required and recommended training available from EH&S for each laboratory employee. EH&S offers required and recommended classes in chemical safety and biological safety, among others. The laboratory safety training matrix is available on the EH&S training page.

Additional training may be required for laboratory research that is outside the scope of EH&S, such as research involving animals, clinical research, funded research, etc.. The UW Office of Research maintains a Required Training webpage to help researchers comply with external sponsor and internal training requirements.

## B. EH&S SAFETY TRAINING RECORDS

EH&S maintains training records for all EH&S provided classes. Managers and individuals may look up training records and print certificates by using the Safety Training Report tool and logging in with their UWNetIDs.

Departments or units may request a copy of personnel training records by contacting EH&S Training at 206.543.7201 or ehstrain@uw.edu.

## C. LABORATORY-SPECIFIC TRAINING AND RECORDS

According to federal, state and local laws and UW policy, Responsible Parties (RPs) are responsible for ensuring that all employees receive adequate training to understand the hazards in their work area. Training must occur prior to assignments involving potential exposure to chemicals.

The laboratory-specific policies on hazard review of new work, working alone or after hours, equipment precautions, use of fire extinguishers and other relevant practices should be documented.
Laboratory personnel must also receive training applicable to all University employees, such as the orientation to the APP and SAPP, which is the department's Health and Safety Plan.

The RP, CHO or supervisor must ensure records of all laboratory-specific safety training are maintained either within the laboratory or at a central location if that is required by the department. The location of the training records must be noted in the Laboratory-Specific Information section of the CHP.

The RP, CHO or supervisor must also keep a copy of safety training content (e.g., a lesson outline and copy of the applicable standard operating procedure) to demonstrate the scope of the training. Such material is useful to provide proof of training during Washington State L&I inspections, to help in training new employees and in providing refresher training if needed.

Training records must be maintained for as long as the trained employee remains on staff. If there is a chance that an employee who left will be returning soon, it might be a good idea to keep the records longer. Laboratories must maintain records of all work-related safety and health training for a specific person for seven years after their employment or work has ended. Employee training may be documented using forms, such as the examples in Appendix C.

Lab specific activities that have any qualification or restrictions should be communicated and documented.

### 1. Undergraduate students in the laboratory

Undergraduate students working in the laboratory may need additional training or oversight or may require demonstration of proficiency; this information should be provided as part of lab-specific training.

Lab activities that require supervision and/or additional training are:

- Use of an open flame.
- Use of hydrogen peroxide at greater than 5% concentration.
- Working with pyrophoric reagents.
- Working with hydrofluoric acid.
- Working with reactions under pressure, using glass or metal reactors, or that may become pressurized.
- Working with radioactive compounds.
- Working in shops.
- Performing any hot work.
- Working with open beam class IIIB or class IV lasers.

The lab-specific training must also identify any hazards of such severity that the risk cannot be justified for an undergraduate researcher. These activities should be prohibited and this restriction should be clearly identified.

If the lab has established limitations on the amount of time that undergraduate students should work in the lab, this information should be provided as part of lab specific training.

Examples of activities that might be prohibited are:

- Working with materials understood to be potentially explosive under ambient conditions.
- Working with replication-competent pathogens that require BSL2+ facilities.
- Supervising another Undergraduate Researcher.
- Working with neat (pure) chemicals having exceptionally potent health hazards as acute toxins, carcinogens, and reproductive toxins.

## D. UW OFFICE OF RESEARCH - RESEARCH REQUIRED TRAINING

The Office of Research offers research-related required training links and transcripts from University departments to help researchers comply with external sponsor and internal requirements, and/or reduce and mitigate risk.

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# SECTION 8 - RECORD KEEPING

***Contents***

# A. CURRENT RECORDS MAINTAINED IN THE LABORATORY/DEPARTMENT

## 1. Chemical Hygiene Plan

The CHP, which is comprised of the online UW LSM plus the laboratory-specific information (e.g., SOPs, laboratory floor plans, chemical spill kit locations and emergency procedures), must be accessible to all employees in the laboratory any time they are working. The laboratory-specific information may be kept electronically (or on paper) and should be updated annually or whenever there are changes. The entire CHP must be reviewed and updated at least once a year by the RP, CHO or laboratory supervisor, and the review should be recorded in the laboratory-specific information documentation area.

## 2. Chemical Inventory

Current chemical inventories must be maintained on the online UW MyChem system for each laboratory. The current inventory must be accessible to all personnel, preferably through MyChem.

## 3. Safety Data Sheets (SDSs)

SDSs are required to be uploaded in MyChem. The master file of SDSs for all known chemicals used on campus is maintained by EH&S and electronic copies of individual SDSs are immediately available on MyChem. (Refer to SDS in Section 2.B.3 of this manual).

## 4. Incident/Accident Reports

Employee incident/accident report records are maintained at EH&S (206.543.7388). Industrial insurance records are maintained in the UW Office of Risk Management (206.543.0183). The RP, CHO or laboratory supervisor must keep copies of all incident/accident or close- call reports filed in the Online Accident Reporting System pertaining to the laboratory or involving laboratory personnel.

## 5. Safety Training Records

Laboratories must maintain records of all work-related safety and health training for current personnel. It is required that records for a specific person are retained for seven years after their employment or work has ended. (Refer to Section7.D for information on what to include in your laboratory training documentation.) EH&S maintains electronic records of attendance at their training classes. University personnel can use the Safety Training Report tool to check their records using their UWNetID. Managers can access training records for all their personnel using UW net IDs.

## 6. Shipping Papers (Bills of Lading)

If chemical-containing items are mailed or moved on or off campus and require shipping papers, these papers must be kept for one year.

## 7. Chemical Treatment Log

You must keep a log of all hazardous waste that you have treated and provide it to EH&S upon request. Keep these logs for six years. The logs must be available for review by county or state inspectors.

## 8. Exposure Monitoring Records

Departments frequently maintain copies of employee exposure monitoring to provide immediate information to their workers if questions arise. These records can be kept in the laboratory or in the department. EH&S maintains records for all exposure monitoring conducted by EH&S. In some cases, laboratories conduct their own employee monitoring. If this occurs, please forward a copy of the monitoring results to EH&S, Box 357165. Exposure monitoring records must be maintained for at least 30 years post exposure.

### 9. Self-inspections

You must conduct at least one self-inspection annually. This should be done independently of any audits, including preparation for visits from the Laboratory Safety Inspection team. Labs with higher turnover, such as teaching labs, should consider conducting self-inspections more than once a year. You can use a copy of the Laboratory Safety Checklist or create a custom checklist. A self-inspection tool is offered on the Lab Safety Dashboard and recommended for use to provide an electronic record easily accessible to the lab and EH&S. Record dates, findings, and follow up activities, and keep records electronically or in paper format.

### 10. Eyewash Flushing Logs

Maintain records of eyewashes flushed for at least one year. Records can be in electronic or paper format.

## B. OBSOLETE AND SUPERSEDED RECORDS FROM THE LABORATORY

Changes in laboratory operations may cause records to become obsolete or superseded.

### 1. Obsolete Exposure Information

Obsolete and superseded information concerning the chemicals in use in a laboratory should be archived and disposed after 30 years when no longer current. These documents include chemical inventories, SOPs, records of spills and accidents and exposure monitoring records.

### 2. Other Obsolete Documents

Records not directly pertaining to potential chemical exposures can be discarded a year after they are no longer current. These records typically include shipping/receiving documents, eyewash flushing logs, and inventory records.

### 3. Records from Decommissioned Laboratories

The department should archive any records pertaining to possible employee exposures for 30 years after decommissioning a laboratory.

## C. EH&S RECORDS

EH&S maintains records for particular areas of responsibility.

### 1. Records Concerning Individuals

#### a. Occupational Exposure Monitoring

EH&S maintains records for all exposure monitoring conducted by EH&S and any results of monitoring conducted by a third party that is reported to EH&S.

#### b. Medical Records

Occupational health medical records for employees are maintained for EH&S in the Husky Health Center Medical Records Division. Confidentiality of medical records is maintained.

### 2. Centralized Records

EH&S is the central repository for chemical inventory records, Accident/Incident Reports, and training performed by EH&S.

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# SECTION 9 – EMERGENCY PREPAREDNESS AND RESPONSE

***Contents***

# A. BEFORE AN EMERGENCY

This section describes emergency guidelines and requirements for laboratory operations. It supplements emergency procedures described in other documents, including your Departmental Health and Safety Plan, Fire Safety Evacuation Plan (FSEP) and the UW Emergency Response Management Plan. General information regarding building emergencies can be found on the EH&S Building Safety Resources webpage or the University's Safety Portal. The RP must prepare laboratory personnel for emergencies, such as injuries, fires or explosions, chemical spills, floods, power failures and earthquakes. To prepare for an emergency, laboratory personnel should plan, obtain response kits and materials and practice responses. New employee laboratory emergency procedures need to be included as part of new employee orientation. All personnel should participate in periodic drills and exercises, including discussions, to keep knowledge current and safety first.

## 1. Planning and Prevention

The University of Washington Police Department (UWPD) and Seattle Fire Department (SFD) provide emergency response to the Seattle campus. Local fire and police departments respond at Bothell, Tacoma, and off-site locations. EH&S will liaise with these organizations and provide advice, but each laboratory is responsible for accident prevention and preparing for laboratory emergencies.

### a. Continuity Planning

A business continuity plan (BCP) should be in place to help 1) minimize the impact on lab activities during any incident and 2) facilitate a return to normal operations. The department may have a broader Business, Academic and Research Continuity (BARC) Plan through the Husky Ready system with some of these details already established; the BCP is meant to supplement and support that system. The template for the BCP is available on the EH&S website.

### b. Accident Prevention

Prevent emergencies in laboratories and minimize the effects of an emergency by doing the following:

1. Post emergency phone numbers, the Exposure Response Poster, and the Spill Response Poster.
2. Identify the locations of emergency equipment on a floor plan; make sure all personnel know the locations of the equipment, such as a spill kit. There are templates to help create a single lab floorplan or a multi-room floorplan template.
3. Keep access to emergency equipment and electrical panels unobstructed.
4. Know locations of shutoffs for equipment including electrical, gas and water.
5. Train personnel to retrieve SDSs for laboratory chemicals using MyChem.
6. Separate incompatible chemicals—refer to the chemical incompatibility chart.
7. Frequently dispose of chemical wastes and clean out unneeded chemicals and surplus; dispose of unneeded items.
8. Ensure electrical wires and equipment are in good condition.
9. Discuss accidents and near misses to prevent future accidents.
10. Periodically complete self-inspections using the laboratory inspection checklist.
11. Discuss safety topics periodically in staff meetings.

**c. Hazards Assessment/Risk Minimization**

When a new experiment or process is in development, assess possible hazards and identify ways to reduce risks. Document this in a risk assessment; guidance and templates are available from EH&S. This is the responsibility of the RP (as described in Section 1.c.) Information about hazards and controls is available in the product SDS and from EH&S at 206.543.7388 or ehsdept@uw.edu.

**d. Fire and Explosion Prevention**

To prevent and minimize the effects of fires and explosions, do the following when using flammable, reactive or explosive materials:

1. Determine if a non-flammable substitute for your material is available.
2. Use a minimum amount of the material at any one time.
3. Maintain proper clearances for aisles, eyewashes, emergency showers and underneath and around sprinkler heads.
4. Close fume hood sashes when they are not in use.
5. Keep containers securely closed.
6. Practice good housekeeping, such as recycling cardboard boxes and properly disposing of unnecessary or outdated chemicals.
7. Have the appropriate fire extinguisher available for the materials in use.
8. Wear fire-resistant lab coats instead of plastic.
9. If using chemicals in a closed system, frequently check that connections are tight.
10. Use chemicals and reaction systems in a ventilated enclosure, such as a fume hood.
11. Reduce or eliminate open flames and spark-producing equipment.
12. Use a refrigerator/freezer designed to store flammable materials.
13. Use barriers that provide adequate protection from an explosion.
14. Consider if utility outages would increase risks while using the material.
15. Anticipate that intermediates and wastes can be flammable or explosive.
16. Use appropriate containers and locations to accumulate wastes.
17. Train personnel on chemicals hazards and precautions; document the training; exercise responses periodically.

**e. Spill Prevention**

Laboratory supervisors should identify chemicals likely to spill during common laboratory procedures, as well as during emergency events, such as earthquakes and fires. The procedures for cleaning spills in a laboratory should be included in the SOPs developed for each of the lab's processes (refer to Section 6 of this manual). Pay special attention to additional precautions for pyrophoric, water reactive, oxidizing chemicals and those that may generate toxic gases if a reaction were to occur.

Use chemicals in small quantities to limit the amount spilled if a container ruptures. Chemicals should be transported between rooms in a tub or bottle carriers designed to prevent breakage and to hold the contents in case of breakage.

All laboratories should have a chemical spill cleanup kit appropriate for the chemicals in the lab.

**f. Earthquake**

Laboratory personnel should be familiar with actions to take during an earthquake. In addition to general procedures such as DROP, COVER and HOLD ON, personnel should know the proper procedures for laboratory evacuation, chemical spills cleanup, and accessing SDSs for emergency response personnel.

Securely fasten heavy or hazardous items that could topple over or block access to emergency exits to the walls or floor. These items include shelving units, equipment racks, equipment or file cabinets taller than 4 feet, distillation units, gas cylinders and cryogenic Dewars; Facilities Services must provide anchors for these items and secure them to the walls or floor. Straps or chains placed at 1/3 and 2/3 of the cylinder height above the floor are recommended. Use two straps for items such as compressed gas cylinders, due to the likelihood that they will fall over during an earthquake if only one strap is used.

Shelves holding chemical containers must have a lip or protective restraint devices to prevent containers from falling off the shelf. Cabinets used to store chemical containers should have a closure device to prevent the door from being shaken open.

**g. Gas Leaks and Unknown Odors**

All personnel need to know which gases and volatile chemicals in their laboratory may produce an odor. Identify contents of pipes, hoses or gas lines with labels. Personnel should know the location of control valves used to shut off gas flow. Discuss incidents with odors, as well as odors from adjacent laboratories, during staff meetings if they are issues.

**h. Utility Outages: Pre-planning and Mitigation**

1. To pre-plan for utility failure, consider the utilities laboratory operations depend on, and then determine if interruptions are unacceptable. Utility outages that can affect laboratory operations include:
    - Electrical power systems.
    - Backup power system or switching systems.
    - Compressed air systems.
    - Ventilation systems (fume hoods, biological safety cabinets, etc.).
    - Natural gas system.
    - Supplied gas systems (medical air, O2, N2O, N2, EtO, etc.).
    - Vacuum system.
    - Potable water systems (loss or contamination).
    - Non-potable water systems (loss or contamination).
    - Sewage systems.
    - Heating systems.
    - Fire protection systems.
    - Refrigeration systems (refrigerators, cold rooms, walk-in freezers, etc.).
    - Elevators.
    - Telephone systems.

- Detection and alarm systems (fire alarms, low airflow alarms, etc.).

2. Actions that can mitigate the effects of shutdowns on laboratory operations include:
    - Backup (split) samples at another location.
    - Records backed up at another location.
    - Emergency power circuits (if available) for equipment.
    - Devices such as water filters for potable water and surge protectors or Uninterruptible Power Systems for electrical power.
    - Plan steps to safely shut the process down and resume again.
    - Plan actions to prevent uncontrolled reactions.
    - Contract for emergency supplies and services.

If using refrigerators or freezers to store specimens, locate a source vendor for dry ice and liquid nitrogen freezers in case of electrical failure.

- Connect incubators, refrigerators, and freezers to battery- powered automatic phone dialing systems or alarm monitoring services to detect power interruptions and alert the designated person.
- Develop procedures for card reader doors and other security systems that typically have a four-hour battery backup; communicate changes to normal access routes.
- Flashlights in areas that do not have emergency lighting; periodically check batteries.
- Alarm systems and appropriate responses (including fire alarms, ventilation system alarms, fume hood low-flow alarms, gas leak detection systems).
- Create personnel communication channels for disaster situations (adverse weather, long-term power outages).
- Safe Chemical Use: such as keeping containers closed.
- Conduct periodic safety trainings, drills, and/or exercises.

**i. Unattended Operations and Floods**

Avoid leaving operations or experiments unattended. If unavoidable, post the name and phone number of the person responsible for the operation on the door to the room in case of emergency. In addition, identify the chemicals in use and post clear directions for shutdown so that an untrained person could shut down the operation during an emergency.
In general, to avoid failures in equipment while no one is in the lab, maintain and operate equipment properly. Replace damaged equipment and electrical cords. Do not use extension cords for hooking up to electrical power; use strip outlets if your cord does not reach the outlet. Check equipment periodically. Discard and replace damaged batteries. Water: If it is necessary to have running water unattended, install a commercial water flow device that sets off an alarm if a leak occurs or use a shutoff valve that kicks in if the water level rises too high. Use copper tubing with proper fittings or Tygon tubing, which is less likely than rubber tubing to become brittle. If using tubing, make sure the ends are tightly connected. Anchor outlet hoses into sinks or drains.

Do not leave open flames unattended.

#### j. Security Issues

Plan for ways to avoid and respond to violence, vandalism, suspicious people, and suspicious packages. Laboratories can be targets for such activities. Related information is available on the UW Emergency Management website.

In general, laboratory security requires students and staff:

1. Know all entry points.
2. Keep doors closed and locked when the lab is unoccupied.
3. Wear identification badges.
4. Never allow a stranger to enter the lab.
5. Do not leave materials and supplies (avoid theft, tampering).
6. Properly dispose of hazardous agents no longer needed.

Depending on the materials in use in the laboratory, higher levels of controls may need to be implemented. These controls may include using codes to identify certain materials and securing them inside the laboratory with access by designated personnel only.

The RP, with the assistance of the department, should determine policies to increase security. All personnel must be reminded of these policies.

#### k. Field Operations

Plan for emergencies that may occur during field laboratory operations. Prepare a written safety plan that takes into account the remoteness of the operation and the risks associated with the activities. Minimum considerations include:

1. Become knowledgeable about potential threats in the area.
2. Determine first aid, CPR and medical response; make first aid kit readily available.
3. Determine “In Case of Emergency” communications plan.
4. Devise alternative plans for inclement weather.
5. Checklists: ensure necessary supplies, equipment, SDSs and SOPs.
6. Insurance: confirm student coverage prior to participating in field activities.

Follow the requirements and recommendations listed in the UW Field Operations Safety Manual.

### 2. Spill, First Aid and Disaster Kits

Purchase emergency kits appropriate for your laboratory. Inspect them routinely (*i.e.*, semi- annually and after use) to make sure they are complete and ready for response.

#### a. Chemical Spill Kits

Labs are required to have a spill kit accessible in their work area. Many safety equipment providers, such as VWR, Grainger and New Pig, offer spill cleanup supplies or kits. Each lab should tailor their kit to their specific operations.

***Table 9-1 Recommended Chemical Spill Kit Contents***

| Item | Description |
|---|---|
| Absorbent | Spill pads, universal for acid, base, oil, solvents |
| Neutralizer | Box baking soda for neutralizing acids |
| Brush, dustpan | One snap together dustpan and whisk broom |
| Plastic bags | Yellow hazardous material heavy duty waste bags |
| Plastic drum | Reusable plastic drum or container to store kit supplies and hold bagged spill waste |
| Goggles | Chemical splash protection goggles |
| Impervious gloves | Silvershield gloves (multi-layer construction, impervious to most chemicals) |
| Lightweight gloves | Powder-free nitrile gloves, various sizes |
| Forms | EH&S Chemical Collection Request and hazardous waste labels |

### b. Mercury Spill Kits

If you work with equipment or instruments containing elemental mercury, consider keeping a mercury spill kit in your lab. Mercury spill kits are available from safety equipment providers, such as VWR, Grainger and New Pig.

### c. Biological Spill Kits

Information on biological spill kits is located on the EH&S website.

### d. First Aid Kits

First aid supplies must be readily available to all employees, and should be stored in clean, clearly marked, portable containers. The containers must not be locked. They must be made of material that protects them from damage, deterioration, or contamination in the work environment. Responsible parties must assess their work environments to determine if, given the hazards in the environment, additional supplies are needed. Personal medications and prescription medicines should be kept in the possession of the person who uses them and not in a shared first aid kit. Consider the following:

- First aid kits don't save lives, people do. Get trained and know how to use everything you put in your kit.
- Commercial first aid kits are good starting points, and options are available through UW e-procurement.
- Customize your kit for your tasks, group size, and level of training.
- Replenish used or expired items.
- Check for expiration dates on medications and sterile items; replace items that may have been torn open or damaged. Many vendors sell refill kits.

First Aid Plan Guidelines from EH&S contain instructions for creating a First Aid Plan for UW personnel on UW campuses, UW-owned sites, UW-leased spaces, temporary field locations, and field trips that are under the control of University operations and personnel.

Laboratories using **hydrofluoric acid** must stock calcium gluconate gel in case of skin contact with the hydrofluoric acid. The gel should be kept in the first aid kit (but may be kept in a spill kit or location close to the work area known by all personnel). The gel has a relatively short shelf life of six months, so the RP, CHO, or laboratory supervisor must replace it periodically.

Disaster Kit information is on the UW Emergency Management website.

## B. RESPONSE TO SPECIFIC INCIDENTS / ACCIDENTS

Emergencies occur in a range of severity. All personnel need to know what to do in case of an emergency such as an injury, exposure, fire, explosion, spills, earthquakes, gas leaks, utility outage, flood, and intruders, suspicious packages, and demonstrators . Additional information on specific emergency procedures and resources is available on the EH&S website.

UW personnel are required to submit an incident report via the Online Accident Reporting System (OARS) for any work-related event that results in an injury, illness, exposure, fire, or property damage. UW personnel are highly encouraged to submit work-related near-miss events. Incident reports can only be submitted by the injured person, their supervisor, or anyone with a UW NetID.

### 1. Accidents Causing Serious Personal Injury or Exposure

For an accident-causing serious personal injury, **call 911** for emergency response as soon as possible while conducting the following first aid responses as appropriate. Do not remove equipment involved in the accident and do not move it unless necessary to provide aid to the victim(s) or to prevent further damage or injury. Depending on the seriousness of the injuries, a formal accident investigation may be required in compliance with Washington State L&I regulations (Washington Administrative Code, WAC 296-800-801-320).

### 2. Chemical Exposure

If a hazardous chemical gets in someone's eyes, flush eyes for at least 15 minutes in the eyewash while holding the eyelids open. Call 911 as soon as possible.

If a toxic or corrosive chemical is on someone's skin, flush the area affected for at least 15 minutes with tepid water. If necessary, use the safety shower and remove contaminated apparel. (For hydrofluoric acid, when calcium gluconate treatment is available, flush skin for five minutes and immediately apply the calcium gluconate. For more details, refer to the at Call 911 as soon as possible.

If a person is exposed to a toxic material in the air, remove the person to fresh air and call 911 as soon as possible. Do not re-enter an area that may still be contaminated.

All personnel in the laboratory should be able to retrieve an SDS for any hazardous chemical in the laboratory so they can bring it to the emergency room. Transporting the victim by ambulance is recommended.

Contact the Occupational Health Nurse at UW Campus Health Services (206.685.1026) if there is a concern about possible long-term health effects from a workplace exposure.

#### a. Reporting

After immediate emergency actions have been taken, report the accident or incident to the work area supervisor, department administrator or other designated department contact as soon as possible. All faculty, staff, students, and visitors are required to report an accident or incident using OARS within 24 hours of the incident or accident if a person was injured or property damage occurred. Report any on-the-job incident that nearly missed causing an injury or illness or property damage.

Notify EH&S immediately (after first aid/medical care) if the incident involves any of the following:

- In-patient hospitalization, amputation, loss of an eye, or fatality
- Recombinant/synthetic DNA/RNA exposure or spill
- Radioactive material spill, exposure, accidental exposure from a radiation producing device or laser
- Fire

During EH&S business hours (8:00 a.m. to 5:00 p.m., Monday to Friday) call (206) 543-7262.

Outside of EH&S business hours, call the UW Police Department at (206) 685-8973 to reach EH&S on-call staff.

EH&S is required to report any employee in-patient hospitalization or fatality to Washington State Department of Labor & Industries (L&I) within eight hours of the incident. Do not move any equipment involved in the incident until EH&S receives clearance from L&I. If the accident results in a fatality or hospitalization, also report the accident immediately to EH&S at 206.543.7262. After routine office hours, EH&S can be contacted via the UW Police Department at 206.685.UWPD (8973).

If the accident involved a University vehicle, it must be reported immediately to the UW Police Department at 911 or 206.685.UWPD (8973), and to UW Fleet Services using the procedures found in the vehicle's glove compartment.

#### b. Medical Treatment Reports

An employee who seeks medical treatment for a work-related injury or illness must submit a State of Washington Accident Report Form (which is initiated by the health care provider) and notify UW Risk Services at 206.543.0183. More information is available at https://risk.uw.edu/.

### 3. Fires and Explosions

In the event of a fire or explosion, **call 911**. If you are uncertain about calling 911, the best course of action is to call 911 and let the dispatch operator assist in deciding a proper response.

Activate the alarm system and evacuate as soon as possible. If your building does not have a fire alarm system, shout "fire" while moving toward the exits. If your department allows use an appropriate fire extinguisher to fight the fire if it is easily extinguished (i.e., smaller than a trash can), you have been trained within the last year on how to use a fire extinguisher and you have a clear exit.

***Report all fires and explosions immediately.*** Even if the fire was small, contained and readily extinguished by laboratory personnel, immediately report the incident to the University Police on the Seattle campus at 206.685.UWPD (8973). For UW Bothell, call the UW Bothell Public Safety Department at 425.352.5359. For UW Tacoma, call Campus Safety Services at 253.692.4425. Regardless of location report to EH&S by calling 206.685.0341 or emailing uwfire@uw.edu

Submit an accident report through OARS.

More guidance on responses to fires and explosions available on the EH&S website.

### 4. Spills

Your response to a spill depends on the danger it poses. Immediately assess the situation and **call 9-11** for any life-threatening emergency. If anyone has been exposed, refer to section **9.B.1. Accidents Causing Serious Injury or Exposure**.

If the spill is within the laboratory personnel's capabilities to cleanup, follow S.W.I.M.:

| | |
|---|---|
| **S:** | **STOP THE SPILL. COVER WITH ABSORBENT MATERIAL.** |
| **W:** | **Warn** others. Alert people in the immediate area of the spill. |
| **I:** | **Isolate** the spill and secure the area. Close doors if possible. |
| **M:** | **Minimize** your exposure by wearing PPE and avoiding contact, inhalation or ingestion. Vacate the area if necessary. Wash hands after handling spill materials. |

For additional information refer to the Spill Response Poster.

#### a. Planning and preparation

To minimize the impact of a spill and support effective spill response, it is required that everyone in the lab knows what to do in response to a spill and the route to the nearest emergency room. Additional considerations for spill response preparations include:

- Adding curtains next to the shower or providing large towels to hold up around the shower in the case someone needs to disrobe
- Providing clothing/scrubs/Tyvek for a person who needs dry clothes after a splash
- Being prepared to address a large volume of water released into that part of the lab if the shower is engaged
- Doing a lab practice or walk through on what to do in the case of a chemical spill

#### b. Documentation and Process Improvement

After the incident, fill out an accident report with your supervisor on the OARS website. Replace used clean-up materials. Determine if additional or other types of cleanup materials would be desirable. Also, discuss, as a group, what could have been done differently. Document any changes by updating the applicable SOP.

#### c. Mercury Spills

Mercury spills are one of the most common spill calls received by EH&S. All departments using mercury should replace their mercury devices if at all feasible. If a mercury spill occurs, prevent entry to the area. Refer to the EH&S Mercury webpage for guidance.

### 5. Earthquake Response

Take shelter under a workbench or other protective cover until the earth movement stops. Afterwards, if safe to do so, shut down any procedures that may be underway and cap any open containers: you may not be allowed to re-enter until the building has been assessed for hazards. Determine if you need to evacuate the work area. Assemble at your location specific Evacuation Assembly Point and await further instructions. Do not re-enter the building until after it has been assessed for structural damage by trained personnel; re-entry is only authorized by University officials.

For further information about earthquake safety, refer to guidelines on the EH&S website and the UW Emergency Management webpage. For free informational handouts on earthquake preparedness (including for home/family), call EH&S Training at 206.543.7201. Visit the UW Emergency Management webpage for more earthquake preparedness information.

### 6. Gas Leaks or Other Odors

#### a. Natural Gas Leaks

1. Natural gas leaks are a potential cause of explosions. Natural gas contains an odorant that enables recognition even at low concentrations. If you smell natural gas in the laboratory, do the following:

- Turn off all sources of ignition (open flames, electrical equipment).
- Check laboratory gas outlets for open valves.
- Call UW Facilities (refer to phone numbers in Appendix F) to have the location of the gas leak identified.

2. For strong, widespread and/or quickly worsening odor:
   - Pull the emergency alarm at a pull station.
   - Turn off all sources of ignition (open flames, electrical equipment).
   - Close the emergency gas valve for your floor or area if one exists.
   - Evacuate the building immediately and go to your assembly area.
   - If your assembly area is downwind of the building, move to an alternate assembly area up wind at least 300 feet from the building.
   - Do not return to an evacuated building unless told to do so by the on-scene authority (fire department, police department or other personnel).
   - Submit an accident report on the online accident reporting system (OARS).

**b. Unusual Odors**

Check with co-workers to determine if they are doing something to produce an odor. If a leaking gas cylinder is suspected, handle it as described in Section 2.G.9.d. If an immediate source cannot be determined in the laboratory, check the hallway and adjacent laboratories to determine if the odor is widespread or if the source is obvious.

Try to relate the odor to possible causes:

- Dried sink drain or floor drain (sewer-like or chemical-like odor).
- Chemical process gone wrong (if a rotting or unknown chemical odor).
- Overheating electronics (if devices are over-heating or smell hot).
- Chemical spill or a leaking process (if a distinct chemical).

If the source is obvious, take action (if possible) to eliminate the cause or control the odor, such as taking a chemical reaction off the benchtop and putting it into a working fume hood.

There are an unlimited number of potential sources, but familiarity with the lab's activities should help narrow the possibilities. Additional information about indoor air quality is available on the EH&S website.

## 7. Utility Outage

Your safety and the safety of those around you is the first consideration during a utility outage. Remain calm. Assess the situation; if conditions seem dangerous, evacuate the area while assisting others to evacuate. Do not re-enter the building until a competent authority has determined it is safe to do so.

If the situation does not seem dangerous, notify your supervisor or the building coordinator of the failure, shut off work in progress that could cause hazards, close containers and fume hood/biosafety cabinet sashes and return hazardous material containers to their proper storage locations. Some utility failures may have insignificant impact on your operations, and you can safely continue work as determined by you and your department/supervisor. Note: emergency lighting

systems are meant to provide light for exciting, not routine, work.

If the failure appears likely to last for a long period, follow your health and safety plan and directions from your department/supervisor. Keep refrigerator and freezer doors closed and implement backup procedures as necessary, such as obtaining dry ice to keep specimen refrigerators cold. When systems return to normal operation, immediately assess the work area (even on weekends, if that is when service is restored) for any hazards that may be present, such as electric devices (heaters, ovens, centrifuges, etc.) left on when the outage occurred.

General information on responses to power outages is available on the EH&S website.

**a. Electrical Failure Procedures**

1. Secure current experimental work, and then move it to a safe location.
2. Close open containers of hazardous materials.
3. Close sashes on fume hoods and biological safety cabinets.
4. When transporting chemicals on carts between floors, get assistance; hazardous spills are a significant risk during transport.
5. Keep lab refrigerators or freezers closed throughout the outage.
6. Unplug personal computers, non-essential electrical equipment and appliances.
7. If asked to evacuate, secure hazardous materials work, and leave the building.
8. Once power is restored, assess the affected area for potentially hazardous situations, such as devices left on; assessment required when power is restored when the facility is closed or unoccupied.

**b. HVAC/Fume Hood Failure Procedures**

- Notify other occupants of the situation.
- Evacuate and pull the fire alarm if warranted, e.g., if smoke is coming into the room.
- Notify your supervisor or building coordinator of the situation.
- Shut down work in progress (if possible and safe to do so):
    - Shut off equipment and supplied gases and liquids.
    - Close open containers.
    - Close sashes on fume hoods and biological safety cabinets.
    - Note the step in your process when work was stopped.
    - Return chemicals and samples or specimens to appropriate storage.
- Once the failure is resolved and prior to re-starting work in the area, review the lab area to identify and mitigate any issues that may have developed.
- In the event of potential exposure to chemical hazards due to system failure during laboratory work, submit an accident report on the online accident reporting system at www.ehs.washington.edu/workplace/accident-and-injury- reporting.
- In the event of damage to equipment due to the system shutdown or failure, submit a work order to Facilities.

## 8. Laboratory Floods

If your laboratory is flooded, find the source of the water and shut the water off. If safe, also shut down any equipment that could cause a dangerous electrical situation during a flood. Cover equipment and desks if water is dripping onto them and get help quickly. During work hours, contact your building coordinator. After hours, call UW Police at 911 if on the UW Seattle Campus or Facilities Services emergency numbers (refer to Appendix F) if at other locations.

Notify the supervisor, RP or department administrator in charge of the flooding laboratory as soon as possible.

If the water is contaminated by chemicals, call EH&S at 206.543.0467. For additional information, on responding to flooding visit the EH&S website.

The best method to clean up uncontaminated water is by using one water vacuum on the scene of the flood and another on the affected area below. Saturated materials (e.g., fabrics and cardboard) need to be dried within 48 hours or will need to be discarded to prevent mold growth. After the cleanup, submit an accident report on the online accident reporting system.

### 9. Inclement Weather

During thunderstorms, shut off electrical equipment that may be sensitive to voltage fluctuations. For other anticipated weather conditions, which may affect your lab's operations, take response actions as indicated in your pre-emergency plans.

Do not drive through flooded areas to get to your laboratory. Minimize your and your lab personnel's driving during heavy snow, ice storms, and extreme icing conditions. You can sign up for the UW Alert system to receive a text message or email if campus operations are suspended or otherwise impacted. You can also call the UW information line at 206.UWS.INFO or check the UW main page for instructions pertaining to University operations.

### 10. Intruders, Suspicious Packages, and Demonstrators

Contact your servicing police department immediately to report a suspicious intruder, or if there is something missing. If a person is acting in a way that indicates they may become violent, follow protocols for handling potentially violent situations as set up by the University and department, such as contacting police, using code words, and maintaining an exit pathway (if possible).

If you find a suspicious package, do not handle it. If you suspect that a package could be explosive, evacuate the area and call 911 from a safe location. If there is noise or wiring coming from the package, the weight of the package is odd for its size, there is liquid or powder leaking from the package, a chemical odor is present, there are odd stains on the package, or if there is excessive packaging, this should alert you that it could be explosive.

If you find a suspicious letter or package, do not handle it. Evacuate the area and call 911. For more information, refer to the US Postal Service Poster on Suspicious Packages or the EH&S bomb threats webpage. In the event of a demonstration adjacent to your laboratory, do not provoke, obstruct, or get into a verbal altercation with the demonstrators. If necessary, move on. Demonstrators are prohibited from blocking free entry to, and exit from, buildings and free movement in public spaces and disrupting or causing obstacles to regular University activities. When you leave your office or lab be sure the door is closed and locked even if you are just going across the hall "for a minute." Do not leave items unattended.

If you refer to anything suspicious or criminal in nature, report it to the police (dial 911). If a disturbance seems threatening, immediately report it to the police (dial 911), alert other personnel in the area of the situation, lock doors and windows and evacuate, if necessary, under the direction of the police or your evacuation warden.

Additional information on civil demonstrations is available on the EH&S website. In all cases, submit an accident report on the online accident reporting system.

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# SECTION 10 – LABS: MOVE IN / MOVE OUT

***Contents***

# A. MOVE IN: OCCUPYING A NEW OR REMODELED LABORATORY

Congratulations on your *new* UW lab space! Occupants moving into new or remodeled laboratory spaces must comply with health and safety regulations designed to keep lab personnel safe.

(Refer to Appendix E, Moving In Checklist, for a comprehensive list of requirements and recommendations for moving into a new laboratory).

## 1. Move Planning

### a. Clearing of Laboratory by Previous Occupants

If possible, visit your space in advance to ensure that the laboratory has been properly cleaned and decontaminated and all chemicals, biological materials, radiological materials and any other hazardous materials have been removed prior to occupancy. If you believe that the space is still contaminated or has not been properly evacuated, contact your Building Coordinator for assistance in locating the previous occupant. (Refer to Appendix E: Moving Out Checklist).

### b. Laboratory Design

If you are modifying an existing laboratory or constructing a new one, refer to the Facilities Support webpage, which outlines requirements and recommendations for new laboratories. For further information about laboratory equipment installation, testing and approvals, etc. contact EH&S at 206.616.3722.

Facilities Services must be enlisted for certain physical work involved with the installation of equipment. This may include, but is not limited to, bolting items to walls or floors and electrical and plumbing work. (Refer to Appendix F).

Ensure that any physical modifications are complete before you begin to handle hazardous materials. This includes electrical work, plumbing, air balancing in the building, and other considerations. Ensure that all fume hoods and biosafety cabinets are certified by EH&S. If your laboratory does not meet your needs, consider obtaining access to another laboratory's equipment or space (e.g., you may want to share a fume hood with another group).

### c. Ordering Specialized Equipment

Order specialized equipment, such as flammable liquid storage cabinets, acid and base storage cabinets, flammable material or explosion-proof refrigerators, fume hoods and biosafety cabinets in advance. Many of these items require approval; refer to Section 4: Equipment and Facilities for more information about equipment approved for purchase at the UW. New fume hoods and biosafety cabinets must be tested and certified by EH&S before use.

### d. Transporting and Storing Hazardous Materials

Plan how and where you will transport and store your materials and equipment so that you can pack and unpack safely and efficiently. You must not block hallways, doorways, or emergency equipment while packing or unpacking. Special arrangements are required with a hazardous materials mover for chemicals, gases, and other hazardous materials. Call EH&S at 206.616.5835 for assistance with moving hazardous materials or 206.543.0463 for assistance with moving radioactive materials. Refer to the Moving In Checklist (Appendix E of this manual) as any items must be completed prior to occupying the lab space.

## 2. Relocation Completion

Use the Moving In/New Laboratory Checklist in Appendix E of this manual and fulfill all health and safety requirements. Fill out this checklist as soon as possible; some items require completion in

advance of your move.

Once you have moved in and completed the checklist, consider routine application of the Annual Laboratory Self-Assessment Checklist (Appendix E) to monitor and evaluate overall conditions and practices in the laboratory.

### 3. Checklist: Moving Into a Laboratory

A comprehensive checklist for moving in is in Appendix E of this manual.

## B. MOVE OUT: VACATING A LABORATORY

Whether a laboratory is completely or partially vacated, you must leave your portion of the laboratory in a clean and safe condition for the new occupants or construction crews. Prior to vacating a laboratory, you must remove all chemicals, biological materials, radiological materials and any other hazardous materials and decontaminate all work surfaces. You must also remove all equipment and instrumentation (unless arrangements have been made otherwise) and any garbage or other items that will not be wanted by the new occupants. All work surfaces, the fume hood, and any equipment or instrumentation left in the lab must have a Cleaning and Decontamination form completed by the lab and attached to the surfaces. EH&S is available to assist with the clearance of your laboratory. It is helpful to contact EH&S a month or two before you move.

Use Moving Out Checklist in Appendix E as a tool for making sure all requirements associated with moving out are completed. EH&S recommends that each laboratory or department develop a list of all the tasks and people assigned to each task.

The responsibilities of the RP, Department, Project Manager (if there is one), and EH&S are listed below:

### 1. Responsibilities

#### a. General Practices

While in the process of vacating or decommissioning a lab space, all safety equipment and safety practices must continue to be maintained, such as continuation of eyewash flushing practices, appropriate chemical storage practices, and proper chemical labeling practices, including waste labeling.

#### b. Responsible Party

The Responsible Party (RP) is responsible for managing the safe removal of hazardous materials and decontamination of the laboratory and equipment when leaving, moving, or closing a laboratory. The RP is required to remove the hazards associated with their work and to provide information about potential hazards (or lack thereof) remaining in the space. The RP is responsible for ensuring the removal of all chemical, biological, and radioactive materials, and their residue from the labs where work was conducted. The RP may delegate tasks to lab personnel and colleagues as appropriate to their level of training, knowledge, and ability; however, in all cases, it remains the RP's responsibility to assure tasks are completed according to the guidelines and specified protocols.

#### c. Project Manager

The Project Manager is responsible for ensuring all steps of a construction or remodeling project are completed. For department-managed projects this person may be a department employee; for Facilities Services projects this person may be a Facilities Services employee. Whichever party contracts for project management services, the contracted individual assumes responsibility for assuring project tasks are completed according to UW policy, project plan and schedule. If the project is sending supplies, equipment, or instrumentation to Surplus, refer to Surplus guidelines.

#### d. Department

The department is responsible for ensuring that Responsible Parties and designated Project Managers manage laboratory closures or moves responsibly. In the event a RP is no longer available to fulfill their duties, the Department must ensure the completion of tasks ordinarily assigned to the RP. If hazardous materials are not responsibly managed and require removal by EH&S or by an outside contractor, the department will be responsible for incurred costs. Any regulatory action or fines resulting from improper management or disposal of chemical waste will be the responsibility of the department. If the department is sending supplies, equipment, or instrumentation to Surplus, refer to Surplus guidelines.

Departments also retain records about chemical exposure and other chemical safety issues. (Refer to Section 8 - Record Keeping).

#### e. EH&S

EH&S is available for advising a Department, RP or Project Manager on environmental, health and safety-related aspects of laboratory deactivations and moves.

- If laboratory operations involved radioactive materials, refer to the Radiation Safety Manual and the Moving Out Checklist (Appendix E of this manual) for additional EH&S roles in laboratory closures.
- If laboratory operations involved biological materials, refer to the Biological Safety Manual and the Moving Out Checklist (Appendix E) for additional EH&S roles in laboratory closures.

### 2. Transportation Requirements and Logistics

#### a. Moving Equipment and Non-Hazardous Items

You may choose to hire an outside moving company or UW Property & Transportation Services to pack and/or move equipment and non-hazardous materials such as glassware, books, and computers. However, moving companies and UW Property & Transport Services are *not* authorized to move hazardous substances.

Lab equipment must be decontaminated before moving from the lab. Information on decontamination is in Sections 4.G. and 4.H of this manual and online.

#### b. Moving Hazardous Materials

Investigators have the option of moving hazardous chemicals themselves, with the guidance of EH&S, or hiring (at their own expense through EH&S) a hazardous materials contractor. If you choose to move chemicals yourself, you can use a cart (if transporting them on campus) or a vehicle, under certain strict conditions. If you use a cart, refer to the requirements (e.g., spill kits, spill training, PPE) under Transporting Chemicals in Section 2.F of this manual. If you choose to use a vehicle, the requirements in Section 2.F apply, along with four addition conditions:

1. The driver must be a UW employee.
2. The vehicle must be a UW-owned vehicle (either owned by the department or rented from UW Motor Pool).
3. The trip must be business-related only.
4. You must inform EH&S exactly what chemicals you will be moving, and chemicals must be in DOT-approved containers. EHS will loan you DOT-approved containers, upon request.

Anyone electing to move hazardous chemicals without the assistance of movers must contact EH&S for guidance before attempting the move. Call 206.616.5835or email chmwaste@u.washington.edu for more information.

#### c. Moving Radioactive Materials

For short moves of radioactive materials between locations on the UW Seattle campus, an investigator may choose to hand carry materials to a new location. Radioactive materials transported in this manner shall be in a closed container and contain diatomaceous earth, or similar absorbent, to mitigate any possible spill.

All vehicular transport of radioactive materials over public roads or distances that require use of a vehicle must be performed by EH&S staff. Contact: 206.543.0463. Radioactive materials must *never* be transported by laboratory personnel in private vehicles or University vehicles.

#### d. Moving Biological Materials

When transporting biological materials, follow the instructions in Appendix C of the UW Biosafety Manual,

#### e. Moving Freezers

The moving company is prohibited from moving freezers containing materials considered infectious, including viral stocks, human or primate diagnostic specimens or liquid nitrogen freezers or dewar flasks. Special arrangements must be made with EH&S to move freezers and dewars containing infectious items. Call 206.616.5835 or email chmwaste@uw.edu for more information.

### 3. Checklist: Laboratory Move Outs

The four major areas to address when vacating a laboratory are chemical safety, radiation safety, biological safety, and general safety, which includes sharps and broken glass. A moving out checklist is in Appendix E of this manual.

The Notice of Laboratory Moveout (UoW 1800) must be completed, signed and posted on the inside of one of the laboratory doors. Consult with your department about their process for posting the forms, as this can vary.

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# APPENDIX A:296-828 WAC (WASHINGTON ADMINISTRATIVE CODE)

# Hazardous Chemicals in Laboratories

**Washington Industrial Safety & Health Act (WISHA) Department of Labor & Industries**
January 2017

Washington Administrative Code:

## Chapter 296-828 WAC

**Safety Standards for Hazardous Chemicals in Laboratories (Form Number F414-135-000) LAST UPDATED: 02/03/2017**

This book contains rules for Safety Standards for hazardous chemicals in laboratories, as adopted under the Washington Industrial Safety and Health Act of 1973 (Chapter 49.17 RCW).

DATE: The new issue date of this book is February 2017. A brief promulgation history, set within brackets at the end of each section, gives statutory authority, administrative order of promulgation, and date of adoption of filing.

**TO RECEIVE EMAIL UPDATES**:

- Sign up for our Listserv at https://public.govdelivery.com/accounts/WADLI/subscriber/new?topic_id=WADLI_19

**TO** PRINT YOUR OWN PAPER COPY OR TO VIEW THE RULE ONLINE**:**

HTML version:
https://app.leg.wa.gov/wac/default.aspx?cite=296-828
PDF version:
https://app.leg.wa.gov/wac/default.aspx?cite=296-828&full=true&pdf=true

**DOSH CONTACT INFORMATION**:

- Physical address: 7273 Linderson Way, Tumwater, WA 98501-5414, located off I-5 Exit 101 south of Tumwater.
- Mailing address: DOSH Standards and Information, PO Box 44810, Olympia, WA 98504-4810.
- Information telephone number is 1-800-4BESAFE

**Also available on the DOSH website**:

- DOSH Core Rules
- Other General DOSH Rules
- Industry and Task-Specific Rules
- Proposed Rules and Hearings
- Newly Adopted Rules and New Rule Information
- DOSH Regional Directives (DRD's)
- DOSH Interim Operations and Interpretive Memoranda (DIOIM)
- Memoranda of Understanding (MOU)

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# APPENDIX B – GLOSSARY

This glossary contains common terms found in the Laboratory Safety Manual and on Safety Data Sheet (SDSs). They were found on the web at www.ilpi.com/msds/ref/index.html.

| Term | Definition |
|---|---|
| **absolute** | A chemical substance that is not mixed, pure. For example, Absolute Alcohol, containing not more than one percent by weight of water. |
| **ACGIH** | American Conference of Governmental Industrial Hygienists, Incorporated. An organization of professional personnel in governmental agencies or educational institutions engaged in occupational safety and health programs. ACGIH develops and publishes recommended occupational exposure limits (see "TLV") for hundreds of chemical substances and physical agents annually. (ACGIH, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634; 513-742-2020, www.acgih.org) |
| **acids** | Any chemical that undergoes dissociation in water with the formation of hydrogen ions. Acids have a sour taste and may cause severe skin burns. Acids turn litmus paper red and have pH values of 0 to 6. |
| **action level** | An exposure limit designated in a WAC, generally derived as an 8-hour time-weighted average, which requires the employer to initiate certain required activities, such as exposure monitoring and medical surveillance. |
| **acute health effect** | An adverse effect on a human or animal body, with severe symptoms developing rapidly and coming quickly to a crisis. Also, see "chronic health effect." |
| **acute toxicity** | The adverse (acute) effects resulting from a single dose of, or exposure to, a substance. Ordinarily used to denote effects in experimental animals. |
| **acutely hazardous waste** | A dangerous material as identified with a dangerous waste number beginning with "P" in WAC 173-303-9903. Contact EH&S at 206-616-5835 for current information. |
| **alkali** | Any chemical substances that form soluble soaps with fatty acids. Alkalis are also referred to as bases. They may cause severe burns to skin. Alkalis turn litmus paper blue and pH values range from 8 to 14. |
| **alopecia** | Loss of hair. |

| Term | Definition |
|---|---|
| **analgesia** | Loss of sensitivity to pain. |
| **anesthesia** | Loss of sensation or feeling. |
| **anhydride** | An oxide or compound that when combined with water gives an acid or base. |
| **anhydrous** | Free of water. |
| **anosmia** | Loss of the sense of smell. |
| **anoxia** | A lack of oxygen from inspired air (literally without oxygen). Also, see “hypoxia.” |
| **ANSI** | American National Standards Institute. A privately funded, voluntary membership organization that identifies industrial and public needs for national consensus standards and coordinates development of such standards. Many ANSI standards relate to safe design/performance of equipment such as safety shoes, eyeglasses, smoke detectors, fire pumps, and household appliances; and safe practices of procedures such as noise measurement, testing of fire extinguishers and flame arresters, industrial lighting practices, use of abrasive wheels, etc. (ANSI, 1819 L Street NW, Suite 600, Washington DC 20036, 202-293-8020, www.ansi.org) |
| **aqueous** | A water-based solution. |
| **aquatic toxicity** | The adverse effects to marine life that result from being exposed to a toxic substance. |
| **argyria** | Local or generalized impregnation (gray-blue color) of the body tissues with silver. |
| **asphyxia** | Lack of oxygen and thus interference with the oxygenation of the blood. Can lead to unconsciousness. |
| **asphyxiant** | A vapor or gas that can cause unconsciousness or death by suffocation (lack of oxygen). Most simple asphyxiates are harmful to the body only when they become so concentrated that they reduce oxygen in the air (normally about 21%) to dangerous levels (18% or lower). Asphyxiation is one of the principal potential hazards of working in confined spaces. |
| **asthma** | A disease characterized by recurrent attacks of dyspnea, wheezing, and perhaps coughing, due to spasmodic contraction of the bronchioles. |
| **ASTM** | American Society for Testing and Materials. A voluntary membership organization whose members devise consensus standards for materials characterization and use. (ASTM, 1916 Race Street, Philadelphia, PA 19103, 215-299-5400.) |
| **asymptomatic** | Neither causing nor exhibiting symptoms. |
| **ataxia** | A loss of muscular coordination. |
| **atrophy** | A wasting or diminution in the size of tissues, organs, or the entire body. |
| **auto-ignition temperature** | The minimum temperature to which a substance must be heated without application of a flame or spark in order to cause that substance to ignite. |

| Term | Definition |
|---|---|
| **bases** | See “alkali.” |
| **boiling point** | The temperature at which a liquid changes to a vapor state, at a given pressure. Flammable materials with low boiling points (below 100 °F) generally present special fire hazards. |
| **bradycardia** | A slow heartbeat. Pulse rate below 60 beats per minute |
| **bronchitis** | Inflammation of the bronchial tubes in the lungs. |
| **buffer** | A substance is a solution that can resist pH change upon the addition of an acidic or basic components capable in solution of neutralizing both acids and bases. |
| **CAA** | Clean Air Act. The federal law enacted to regulate/reduce air pollution. Administered by the EPA. |
| **C or ceiling** | The maximum allowable human exposure limit for an airborne substance; not to be exceeded even momentarily. Also, see “STEL” and “TWA.” |
| **carcinogen** | A substance that causes cancer. Also, see “select carcinogen.” |
| **CAS number** | An assigned number that identifies the material. CAS stands for Chemical Abstracts Service, a Columbus, Ohio organization that indexes information published in Chemical Abstracts by the American Chemical Society and provides index guides by which information about particular substances may be located in the Abstracts when needed. CAS numbers identify specific chemicals and are assigned sequentially. (Chemical Abstracts Service, Division of American Chemical Society, Box 3012, Columbus, OH 43210, 614-447-3600, www.cas.org).<br>Fun Fact: The CAS number takes the form of xxxxxx-yy-z, where the “x” series can be any number of 50 or greater up to 6 digits long, and “z” is a digital check derived by multiplying each “y” and “x” digit by a factor (the number of places away from the “z”), and summing these results. Then “z” must be the units digit in the sum. For example, CAS number 591-78-7 is incorrect, because (8 x 1) + (7 x 2) + (1 x 3) + (9 x 4) + (5 x 5) equals 8 + 14 + 3 + 36 + 25 which equals 86. So the “z” must have been “6.” The number “591-78-6” is a correct CAS number and is assigned to methyl-n-butyl ketone. (Note: Perhaps the “z” number was actually “7,” and a mistake was made at a different part of the number? Perhaps “591-79-7” or “591-87-7” was the number they meant to write down.) |
| **caustic** | See "alkali" |
| **central nervous system** | The brain and spinal cord. |
| **CERCLA** | Comprehensive Environmental Response, Compensation, and Liability Act of 1980. Provides for a fund, Superfund, to be used for the cleanup of abandoned hazardous waste disposal sites. |
| **CFR** | Code of Federal Regulations. A collection of the regulations that have been promulgated under US law. |
| **CHAC** | Chemical Hazards Advisory Committee. A UW committee composed of personnel from various departments throughout the University, to provide guidance on policies and procedures concerning chemical use. |
| **chemical family** | A group of single elements or compounds with a common general name. Example: Acetone, methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK) are of the ketone family; acrolein, furfural, and acetaldehyde are of the aldehyde family. |

| Term | Definition |
|---|---|
| **chemical hygiene officer** | See "CHO" |
| **chemical hygiene plan** | See "CHP" |
| **CHEMTREC** | Chemical Transportation Emergency Center. The national center established by the Chemical Manufacturers Association (CMA) in Washington, DC, in 1971, to relay pertinent emergency information concerning specific chemicals on request. CHEMTREC has a 24-four toll free telephone number (800-424-9300), intended primarily for use by those who respond to chemical transportation emergencies. (www.chemtrec.org) |
| **CHO** | Chemical Hygiene Officer. An employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure. At the UW, the CHO is designated for each laboratory as an individual familiar with the rules, processes and required personal protective equipment and has the authority to enforce proper procedures in that lab. The UW CHO provides guidance and advises concerning policies university-wide |
| **CHP** | Chemical Hygiene Plan. The written guidance document required to meet the laboratory safety standard, WAC 296-828, Hazardous Chemicals in Laboratories. It must address all potential exposures to health hazards from the chemicals in the laboratory and is achieved at the UW by adding laboratory- specific information to a generalized manual. |
| **chronic health effect** | An adverse effect on a human or animal body, with symptoms that develop slowly over a long period of time or that recur frequently. Also, see “acute health effect.” |
| **chronic toxicity** | Effects resulting from repeated doses of or exposures to a substance over a prolonged period of time. |
| **CO** | Carbon monoxide. A colorless, odorless, flammable and very toxic gas produced by the incomplete combustion of carbon; also a by- product of many chemical processes. |
| **CO2** | Carbon dioxide. A heavy, colorless gas produced by the combustion and decomposition of organic substances and as a by- product of many chemical processes. CO2 will not burn and is relatively nontoxic (although high concentrations, especially in confined spaces, can create hazardous atmospheres and breathing difficulties). |
| **combustible** | A term used by NFPA, DOT, and others to classify certain liquids that will burn, on the basis of flash points. Both NFPA and DOT generally define combustible liquids as having a flash point of 100 °F (37.8 °C) or higher. Non-liquid substances such as wood and paper are classified as ordinary combustibles by NFPA. Also, see “flammable.” |
| **common name** | A designation for a material other than its chemical name, such as code name, code number, trade name, brand name, or generic name. |
| **concentration** | The relative amount of a substance when combined or mixed with other substances. Examples: 2 ppm hydrogen sulfide in air, or a 50% percent caustic solution. |
| **conjunctivitis** | Inflammation of the conjunctiva, the delicate membrane that lines the eyelids and covers the eyeballs. |

| Term | Definition |
|---|---|
| **control area/ control zone** | This is a building or portion thereof in which hazardous materials are manufactured, used, dispensed, or stored. Control areas are separated from each other with fire rated construction. In most cases a control area is a single floor in a building, but design options vary. |
| **cornea** | Transparent structure of the external layer of the eyeball. |
| **corrosive** | A chemical that causes visible destruction of or irreversible alterations in living tissue by chemical action at the site of contact; or in the case of leakage from its packaging, a liquid that has a severe corrosion rate on steel. A solid or liquid waste that exhibits a "characteristic of corrosivity," as defined by RCRA, may be regulated (by EPA) as a hazardous waste. |
| **corrosivity** | One of the characteristics of hazardous waste, it refers to the pH of an acid or base or its ability to corrode steel. |
| **CPSC** | Consumer Products Safety Commission. The federal agency with responsibility for regulating hazardous materials when they appear in consumer goods. For CPSC purposes, hazards are defined in the Hazardous Substances Act and the Poison Prevention Packaging Act of 1970. |
| **cutaneous** | Pertaining to the skin |
| **CWA** | Clean Water Act. The federal law enacted to regulate/reduce water pollution. Administered by the EPA. |
| **cyanides** | Any of various salts or esters of hydrogen cyanide containing a CN group, including the extremely poisonous compounds potassium cyanide and sodium cyanide. Segregate from acids and oxidizers. |
| **cyanosis (cyanotic)** | A dark purplish coloration of the skin and the mucous membrane due to deficient oxygenation of the blood. |
| **decomposition** | Breakdown of a material or substance (by heat, chemical reaction, electrolysis, decay, or other processes) into parts or elements or simpler compounds. |
| **dermal** | Used on or applied to the skin. |
| **dermal toxicity** | Adverse effects resulting from the skin's exposure to a substance. |
| **dermatitis** | Inflammation of the skin. |
| **designated area** | An area that may be used for work with "select carcinogens," reproductive toxins, highly toxic chemicals or highly dangerous chemicals. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood. |
| **diaphoresis** | Perspiration. |
| **disposal** | The discharge, deposit or placing of waste into the environment, usually by incineration or burial in landfills. |
| **DOT** | U.S. Department of Transportation. A federal agency which regulates transportation of chemicals and other substances to aid in the protection of the public as well as fire, law enforcement, and other emergency response personnel, particularly when transportation incidents occur involving hazardous materials. Detailed DOT classification lists specify appropriate warnings such as "Oxidizing Agent" or "Flammable Liquid" that must be used for various substances. |
| **DOT numbers** | Identification numbers that are four-digits preceded by "UN" or "NA" and are used to identify particular substances for regulation of their transportation. See the DOT publications that describe the regulations. |
| **dyspnea** | A sense of difficulty in breathing; shortness of breath. |

**EAP** Evacuation Assembly Point. The location building occupants would congregate if the building needs to evacuate. This information can be found in your building's evacuation plan and on maps located throughout the building. If you cannot determine your EAP contact EH&S at 206.654.0341.

**edema** An abnormal accumulation of clear, watery fluid in the tissues.

**EH&S** The University of Washington Department of Environmental Health and Safety. Box 354400, 201 Husky Health Center, Seattle, Washington 98195, 206.543.7262.

**electrolyte** Any substance that conducts an electric current in solution.

**embolism** Obstruction of a blood vessel by a transported clot, a mass of bacteria, or other foreign material.

**emphysema** A swelling or inflation due to presence of air in the connective tissues of the lungs.

**employee** An individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

**EPA** U.S. Environmental Protection Agency. The federal agency with environmental protection regulatory and enforcement authority. Administers the CAA, CWA, FIFRA, RCRA, TSCA, and other Federal environmental laws.

**epidemiology** The science which deals with the study of disease in a general population. Determination of the incidence (rate of occurrence) and distribution of a particular disease (as by age, sex, or occupation) may provide information about the causes of the disease.

**epistaxis** Nosebleed; hemorrhage from the nose.

**evaporation rate**

The rate at which a particular material will vaporize (evaporate) when compared to the rate of vaporization of a known material. The evaporation rate can be useful in evaluating the health and fire hazards of a material. The known material is usually normal butyl acetate (NBUAC or n-BuAc), with a vaporization rate designated as 1.0. Vaporization rates of other solvents or materials are then classified as fast, medium or slow, as compared to n-butylacetate, with examples shown in Table B-1.

| | Evaporation Rate | Examples |
|---|---|---|
| Fast | > 3.0 | Hexane - 8.3<br>Acetone - 5.6<br>Methyl ethyl ketone (MEK) - 3.8 |
| Medium | 0.8 to 3.0 | Methyl isobutyl ketone (MIBK) - 1.6<br>190-proof (95%) Ethyl alcohol-1.4<br>VM&P naphtha - 1.4 |
| Slow | < 0.8 | Xylene - 0.6<br>Water - 0.3 Mineral spirits - 0.1 |

| Term | Definition |
|---|---|
| **explosive** | A material that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature. |
| **extinguishing media** | The type of fire extinguisher or extinguishing method appropriate for use on a specific chemical. For example, some chemicals react violently in the presence of water, so other types of extinguishing media would be necessary to control a fire. |
| **Extremely Hazardous Waste (EHW)** | Any dangerous waste which will persist in a hazardous form for several years or more at a disposal site and in its persistent form:<br>• Presents a significant environmental hazard and may be concentrated by living organisms through a food chain or may affect the genetic makeup of human beings or wildlife.<br>• Is highly toxic to human beings or wildlife (LD50 Oral (rat) <50mg/kg) |
| **FDA** | U.S. Food and Drug Administration. The federal agency which, under the provisions of the Food, Drug and Cosmetic Act, establishes requirements for the labeling of foods and drugs to protect consumers from misbranded, unwholesome, ineffective, and hazardous products. The FDA also regulates materials for food contact service and the conditions under which such materials are approved. |
| **fibrosis** | Formation of fibrous tissue, as in a reparative or reactive process, in excess of amounts normally present. |
| **FIFRA** | Federal Insecticide, Fungicide, and Rodenticide Act. The federal legislation administered by EPA concerning control of chemicals designed to kill organisms. Part of the legislation requires that certain useful poisons sold to the public, such as chemical pesticides, contain labels that carry health hazard warnings to protect users. |
| **flammable** | Describes any solid, liquid, vapor, or gas that will ignite easily and burn rapidly. A flammable liquid is defined by NFPA and DOT as a liquid with a flash point below 100 °F (37.8 °C). (Hazardous waste definition is less than 140 °F.) |
| **flammable limits** | The minimum and maximum concentrations of a flammable gas or vapor between which ignition can occur. Concentrations below the lower flammable limit (LFL) are too lean to burn, while concentrations above the upper flammable limit (UFL) are too rich. All concentrations between LFL and UFL are in the flammable range, and special precautions are needed to prevent ignition or explosion. |
| **flash point** | The temperature at which a liquid will give off enough flammable vapor to ignite. There are multiple ways to test the flash point. |
| **FSEP** | Fire Safety and Evacuation Plan. This evacuation plan covers an entire building but allows for individual departments to modify sections to fit their needs. The plan will indicate where the official assembly point is if you need to evacuate the building and information about fire alarm systems. Contact your Building Coordinator or EH&S at 206.685.0341 if you have not received a copy of your building's plan. |
| **fume hood** | (Laboratory type): A device located in a laboratory, enclosed on five sides with a moveable or fixed partial sash enclosing on the remaining side. Constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.<br>Note: Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that<br>the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals. |

| Terms | Definition |
|---|---|
| **gangrene** | Death of tissue combined with putrefaction. |
| **gastroenteritis** | Inflammation of the stomach and intestines. |
| **general exhaust** | A system for exhausting air containing contaminants from a general work area. Also, see "local exhaust." |
| **generic name** | A designation or identification such as code name, code number, trade name, or brand name used to identify a chemical other than by its chemical name. |
| **gingivitis** | Inflammation of the gums. |
| **GHS** | Globally Harmonized System for the Classification and Labeling of Chemicals (GHS). An international agreement to classify chemicals into certain categories that have specific hazards and warnings, and to use a consistent label format and a consistent Safety Data Sheet (SDS) to provide information to those who use the chemical. The classification scheme used to set the OSHA standard is at www.unece.org/trans/danger/publi/ghs/ghs_rev01/01files_e.html. |
| **H occupancy** | Also known as Hazardous occupancy. This is a room or building designed to house quantities of hazardous chemicals. H occupancies may have protected electrical systems, spill control and secondary containment for sprinkler water. An H room is required when a "control area" exceeds its "MAQ" see definitions. |
| **hazardous chemical** | A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. See "health hazard" and "physical hazard." Note: The Global Hazard System for Hazard Communication at WAC 296-901 provides further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard. |
| **Term** | Definition |
| **hazardous waste** | Any substance that (a) has a characteristic of hazardous waste (i.e., ignitability, corrosivity, etc.), or (b) is included by name in hazardous waste regulations. |
| **health hazard** | A chemical which can cause measurable adverse effects on a human upon being absorbed into the body, such as irritants, corrosives, carcinogens, sensitizers, hepatotoxicants, nephrotoxicants, neurotoxicants, reproductive toxicants, toxic or highly toxic agents, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes or mucous membranes. |
| **hematuria** | The presence of blood in the urine. |
| **hepatic** | Pertaining to the liver. |
| **HHS** | U.S. Department of Health and Human Services. A federal agency created in 1980 to replace the Department of Health, Education, and Welfare (DHEW) as parent for NIOSH, Public Health Service, and other agencies related to health and safety. |

| Terms | Definition |
|---|---|
| **highly dangerous** | Chemicals which have extreme hazard due to flammability or reactivity. The criteria for being considered highly dangerous at the UW is an NFPA rating of four for flammability or a reactivity rating of three or four. |
| **highly toxic** | The following criteria identify highly toxic chemicals in accordance with OSHA and Washington State regulations for identification on MSDSs/SDSs and when determining controls, based on mammalian testing:<br>• Oral route: LD50 of 50 mg/kg or less when administered to albino rats weighing 200-300 grams each.<br>• Dermal route: LD50 of 200 mg/kg or less when administered by continuous contact for 24 hours with the bare skin of albino rabbits weighing 2-3 kilograms.<br>• Inhalation route: LC50 in air of 200 ppm or less (gas or vapor) or 2 mg/l or less (mist, fume, or dust) when administered by continuous inhalation for one hour to albino rats weighing 200-300 grams each. |
| **hygroscopic** | Readily absorbs moisture from the air. |
| **hypergolic** | Describing rocket fuel or propellant that consists of combinations of fuels and oxidizers that ignites spontaneously on contact. |
| **hypoxia** | Insufficient oxygen especially applied to body cells. |
| **Term** | Definition |
| **IARC** | International Agency for Research on Cancer. One of the sources that OSHA refers to for data on whether a material is a carcinogen. (www.iarc.fr/) (A subsidiary agency of the World Health Organization, with US offices at 525 23rd Street NW, Washington DC 20037, 202- 974-3000, www.who.int/en/.) |
| **IFC** | International Fire Code. This code is updated periodically, and after being published, the version needs to be adopted by the Bothell, Seattle and Tacoma Fire Departments for implementation in the building codes affecting UW facilities at those campuses. Contact EH&S Building and Fire Safety Office at 206.685.0341 for advice about current codes. |
| **ignitability** | One of the characteristics of a hazardous waste, it refers to the waste's ability to burn. |
| **incompatible** | A combination of chemicals which could cause dangerous reactions after direct contact with one another. |
| **inflammation** | A series of reactions produced in the tissues by an irritant, injury, or infection characterized by redness and swelling caused by an influx of blood and fluids. |
| **ingestion** | The taking in of a substance through the mouth, typically swallowing and passing it into the digestive system. |
| **inhalation** | The breathing in of a substance in the form of a gas, vapor, fume, mist, or dust. |
| **inhibitor** | A chemical that is added to another substance to prevent or slow down an unwanted chemical reaction from occurring. |
| **irritant** | Chemicals that causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. |
| **isomers** | In chemistry, chemical compounds that have the same molecular weight and atomic composition but differ in molecular structure (e.g., 1-propanol and 2-propanol are isomers). |
| **jaundice** | Yellowish discoloration of the skin, whites of eyes, and bodily fluids with bile pigment (bilirubin) caused by any of several pathological conditions that interrupt liver function. |

| Terms | Definition |
|---|---|
| **L&I** | Department of Labor and Industries. The State of Washington agency that is responsible for administering worker safety and health regulations in Washington (www.wa.gov/lni). |
| **laboratory** | An area where chemical manipulations are done for either research, educational, or clinical purposes. |
| **Term** | Definition |
| **lacrimation** | Secretion and discharge of tears |
| **lavage** | A washing of a hollow organ, such as the stomach. |
| **LC50** | Lethal concentration 50. The concentration of a material that on the basis of laboratory tests has been shown to kill 50% of a group of test animals when administered as a single exposure (usually 1 or 4 hours). The LC50 is expressed as parts of material per million parts of air by volume (ppm) for gases and vapors, or as micrograms per liter of air (ug/l) or milligrams per cubic meter of air (mg/m3) for dusts, mists, gases or vapors, or as ppm or mg/l by mass of material in water. |
| **LD50** | Lethal dose 50. A single dose of a material that on the basis of laboratory tests is expected to kill 50% of a group of test animals. The LD50 dose is usually expressed as milligrams or grams of material per kilogram of animal weight (mg/kg or g/kg). |
| **LEL or LFL** | Lower Explosive Limit or Lower Flammable Limit. For a vapor or gas; the lowest concentration (lowest percentage of the substance in air) that will produce a flash of fire when an ignition source (heat, arc, or flame) is present. At concentrations lower than the LEL, the mixture is too lean to burn. Also, see "UEL or UFL." |
| **lesion** | Abnormal change, injury, or damage to tissue or to an organ. |
| **leukemia** | A progressive, malignant disease of the blood-forming organs. |
| **LFL** | Lower Flammable Limit. See "LEL or LFL." |
| **light sensitive chemicals** | Chemicals that may react violently or degrade in the presence of light. Store in amber bottles in a cool, dry, dark place. |
| **local exhaust** | A mechanical ventilation system for capturing and exhausting contaminants from the air at the point where the contaminants are produced (welding, grinding, sanding, other processes or operations), as opposed to general exhaust. The work area is often partially enclosed to improve the capture of the contaminants. |
| **MAQ** | Maximum Allowable Quantity. This is the total amount of a type of hazardous chemical allowed within a single Control Area (see "control area/zone") |
| **malaise** | A feeling of general discomfort, distress, or uneasiness; an out-of- sorts feeling. |
| **Term** | Definition |
| **mechanical exhaust** | A powered device, such as a motor-driven fan or air/stream venturi tube, for exhausting contaminants from a workplace, vessel, or enclosure. |
| **medical consultation** | Consultation which takes place between an employee and a licensed physician or other healthcare provider for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place. |
| **melting point** | The temperature at which a solid substance changes to a liquid state. For mixtures, the melting range may be given. |

| Term | Definition |
|---|---|
| **mil** | Generally, one one-thousandth of something. With respect to protective gloves, a unit of thickness equal to one thousandth of an inch. Thin, surgical gloves may be five to seven mils thick. Many industrial gloves are 20 to 35 mils thick. |
| **mutagen** | A substance or agent capable of altering the genetic material in a living cell. |
| **MyChem** | A computer network database established to give access to SDSs, to surplus chemical exchange, and to site-specific chemical information including chemical inventories. |
| **nanoparticle** | A particle having at least one dimension on the scale of 100 nanometers or smaller, where chemical and physical properties may differ from bulk material properties. Typically the term applies to deliberately human-designed particles and not those which may occur in nature such as proteins or as a byproduct of other processes, such as the release of nanoparticle-sized combustion products. |
| **narcosis** | Stupor or unconsciousness produced by some narcotic drug |
| **nausea** | Tendency to vomit, feeling of sickness at the stomach. |
| **necrosis** | Local death of tissue. |
| **neoplasm** | A new or abnormal growth of tissue in which the growth is uncontrollable and progressive. |
| **Term** | Definition |
| **negative pressure** | The environmental condition when the air pressure inside a room or containment device is less than the air pressure outside the area of interest. When a fume hood is running, it must be at negative pressure to the rest of the room. This is desirable because hazardous chemicals inside the area of interest will be less likely to escape, because air leaks will be into the area. Also, see “positive pressure.” |
| **neutralization** | A method of chemically treating corrosive hazardous waste by the addition of an acid or base to make the waste neutral. |
| **NFPA** | National Fire Protection Association. An international voluntary membership organization to promote/improve fire protection and prevention and establish safeguards against loss of life and property by fire. Best known on the industrial scene for the National Fire Codes, standards, recommended practices, and manuals developed (and periodically updated) by NFPA technical committees. Among these is NFPA 704. It contains the code for showing hazards of materials using the familiar diamond-shaped label or placard with appropriate numbers or symbols. |
| **NIOSH** | National Institute for Occupational Safety and Health. A research agency within the Public Health Service, U.S. Department of Health and Human Services (DHHS) which--among other activities--tests and certifies respiratory protective devices, recommends occupational exposure limits for various substances, and assists OSHA in occupational safety and health investigations and research. (www.cdc.gov/Niosh/homepage.html ) |
| **NTP** | National Toxicology Program. A group within the U.S. Department of Health and Human Services which produces the Annual Report on Carcinogens. |
| **nystagmus** | Spastic, involuntary motion of the eyeballs in a horizontal, rotary, or vertical direction. |
| **olfactory** | Relating to the sense of smell. |

| Term | Definition |
|---|---|
| **oliguria** | Scanty or low volume of urine. |
| **opaque** | Impervious to light rays. |
| **oral** | Used in or taken into the body through the mouth. |
| **OSHA** | Occupational Safety and Health Administration. The federal agency charged with developing and enforcing regulations to protect workers. www.osha.gov/. Alternatively, the Occupational Safety and Health Act (1970), the federal act requiring worker protection programs. |
| **Term** | Definition |
| **oxidation** | In a literal sense, oxidation is a reaction in which a substance combines with the oxygen provided by an oxidizer or oxidizing agent. An oxidizer or oxidizing material is a substance that yields oxygen readily to stimulate the combustion of organic matter such as ozone or chlorinated trisodium phosphate. |
| **oxidizers** | Chemicals, other than a blasting agents or explosives, that initiate or promote combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases (e.g. chlorate, permanganate, and nitrate compounds). |
| **palpitation** | Irregular rapid heartbeat. |
| **particularly hazardous substances** | Chemicals that are “highly toxic,” “highly dangerous,” “select carcinogens,” “reproductive toxins,” or “select toxins.” Criteria provided at https://www.ehs.washington.edu/resource/particularly-hazardous-substances-655 |
| **PEL** | Permissible Exposure Limit (PEL). The exposure limit established in accordance with the Washington Industrial Safety and Health Act (WISHA). The PEL may be a time-weighted average (TWA) limit of average exposures throughout the work day, or an exposure limit for a shorter period of time. Additional information about Washington State’s PELs is provided in the Employee Health Section of this manual. |
| **percent volatile by volume** | The percentage of a liquid or solid (by volume) that will evaporate at an ambient temperature of 70 °F (unless some other temperature is stated). Examples: butane, gasoline, and paint thinner (mineral spirits) are 100% volatile; their individual evaporation rates vary, but over a period of time each will evaporate completely. |
| **peroxidizable chemicals** | Chemicals that may become shock sensitive or explosive when they oxidize to form an appreciable concentration of peroxides. Also referred to as “peroxide-forming” chemicals. |
| **pH** | The value that represents the acidity or alkalinity of an aqueous solution. The number is the logarithm, to the base 10, of the reciprocal of the hydrogen-ion concentration of a solution. Pure water has a pH of 7. The substance in an aqueous solution will ionize to various extents giving different concentrations of H+ and OH- ions.<br>For example, the strongest acids have an excess of H+ ions and a pH of 1 to 3 (HCl, pH=1). The strongest bases have an excess of OH- ions and a pH of 11 to 13 (NaOH, pH = 12). The pH scale is logarithmic and the intervals are exponential, so the progression of values represents far greater concentrations than one would suspect (i.e., pH of 3=10,000 to 1 ratio of H+ ions, while a pH of 4=1000 to 1, pH of 5=100 to 1). |

| Term | Definition |
|---|---|
| **phlegm** | Thick mucus from the respiratory passages. |
| **physical hazard** | According to the Laboratory Safety Standard (WAC 296-828), a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive. More generally, an environmental condition that can cause a mechanical injury to a human or acts from a distance (such as radiation or noise). |
| **pneumoconiosis** | Respiratory tract and lung condition caused by inhalation and retention of respirable material. |
| **polymerization** | A chemical reaction in which one or more small molecules combines to form larger molecules. A hazardous polymerization is such a reaction that takes place at a rate that releases large amounts of energy. |
| **positive pressure** | An environmental condition when the air pressure inside a containment device or a room is higher than the outside air pressure. Air contaminants outside the glove box or room will be less likely to enter and contaminate the device or room, because air leaks and currents will tend to blow them out. Also, see "negative pressure." |
| **PPE** | Personal Protective Equipment. Items worn by an individual such as an apron, faceshield, gloves, respirator or hearing protective devices, to prevent illness or injury. |
| **ppm** | Parts per million. A measure of the concentration of a gas or vapor in air; the number of molecules of vapor or gas per million molecules of air. |
| **precipitation** | A method of chemically treating hazardous wastes in which a substance is separated from solution or suspension by a chemical or physical change. |
| **prostration** | Physical exhaustion and incapacitation. |
| **pulmonary edema** | Fluid in the lungs. |
| **pyrophoric** | Chemicals that will ignite spontaneously in air below 130 °F (54 °C). (e.g., white phosphorus.). |
| **RCRA** | Resource Conservation and Recovery Act. The federal legislation that requires controls be placed upon disposal of hazardous waste materials, administered by the EPA. |
| **reactivity** | A description of the tendency of a substance to undergo chemical reaction with the release of energy. Undesirable effects such as pressure buildup; temperature increase; or formation of noxious, toxic, or corrosive byproducts may occur because of the reactivity of a substance to heating, burning, direct contact with other materials, or other conditions in use or in storage. |
| **recycling** | The action or process of converting waste into reusable material. |
| **Term** | Definition |
| **reproductive toxicants** | Chemicals that affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis). |
| **respiratory system** | The breathing system, includes the lungs and air passages (trachea or windpipe, larynx, mouth, and nose), as well as the associated nervous and circulatory supply. |
| **RP** | Responsible Party. The senior researcher who has control over a laboratory's spaces and processes. |
| **S or Skin** | A notation found in SDSs or regulatory standards that is used to indicate possible significant contribution to overall exposure to a chemical by way of absorption through the skin, mucous membranes, and eyes by direct or airborne contact. |
| **Safety Data Sheet** | A document describing a chemical's known hazards, which is produced by the chemical manufacturer and provided to the chemical user as required by OSHA. |

| Term | Definition |
|---|---|
| **SARA Title III** | Superfund Amendments and Reauthorization Act, Title III: Also known as the Emergency Planning and Community Right-to-Know Act of 1986, administered by EPA, which requires notification of local emergency response agencies as to the amounts of hazardous materials stored by an employer. |
| **satellite generator** | A collection area near a hazardous waste's point of generation that is under the control of the person generating the waste. |
| **sclerae** | The tough, white, fibrous covering of the eyeball. |
| **SDS** | Safety Data Sheet. A document similar to a Material Safety Data Sheet and prepared in accordance with the 2012 Hazard Communication (29 CFR 1910.1200) rule change by OSHA, which implements the Globally Harmonized System for Classifying and Labeling Chemicals (GHS). |
| **Secondary containment** | A tub, basin, pan, lined box, impervious berm or other type of larger containment system surrounding chemical bottles or cans in storage or use, and able to hold the contents of the largest container of chemical if it were to break open or spill. |
| **select agent** | Highly toxic organisms and toxins regulated by the U.S. Department of Health and Human Services. Also, see "select toxin." |
| **Term** | Definition |
| **select carcinogen** | Any chemical that meets one of the following criteria:<br>• It is regulated under WISHA as a carcinogen;<br>• It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition);<br>• It is listed under Group I ("carcinogenic to humans") by the International Agency for Research on Cancer (IARC) Monographs (latest editions); or<br>• It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:<br>  ○ After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3;<br>  ○ After repeated skin application of less than 300 mg/kg of body weight per week; or<br>After oral dosages of less than 50 mg/kg of body weight per day. |
| **select toxin** | A highly toxic select agent chemical regulated by the U.S. Department of Health and Human Services. If a select toxin has its LD50 greater than 0.1 micrograms per kilogram when tested using vertebrates, it is exempt from additional requirements for select agents when it is being used in biomedical research. |
| **sensitization** | An immune response reaction states in which further exposure elicits an immune or allergic response. A person previously exposed to a certain material is more sensitive when further contact with this material is encountered. |
| **sensitizer** | A substance that on first exposure causes little or no reaction in man or test animals, but which on subsequent exposure may cause a marked response not necessarily limited to the contact site. Skin sensitization is the most common form of sensitization in the industrial setting, although respiratory sensitization to a few chemicals is also known to occur. |

| Term | Definition |
|---|---|
| **SFC** | Seattle Fire Code. Based on the current International Fire Code (IFC) with some amendments specific to the City of Seattle. |
| **SFD** | Seattle Fire Department. |
| **skin** | See "S." |
| **solid waste** | With respect to chemical substances, a non-hazardous chemical waste. A solid waste may be a liquid, gas, or solid. |
| **Term** | Definition |
| **solubility in water** | A term expressing the percentage of a material (by weight) that will dissolve in water at ambient temperature. Solubility information can be useful in determining spill cleanup methods and fire-extinguishing agents and methods for a material. Terms used to express solubility are:<br>● Negligible = Less than 0.1 percent;<br>● Slight = 0.1 to 1.0 percent;<br>● Moderate = 1 to 10 percent;<br>● Appreciable = More than 10 percent;<br>Complete = Soluble in all proportions. |
| **solvent** | A material that can dissolve other materials to form a uniform mixture. Water is a solvent for many chemicals. |
| **SOP** | Standard Operating Procedure. A document that lists specific work practices for a process or operation. |
| **spasm** | An involuntary, convulsive muscular contraction. |
| **species** | A biological type; on MSDSs, species refers to the test animals (usually rats, mice, or rabbits) which were used to obtain the toxicity test data reported. |
| **specific gravity** | An expression of the density (or heaviness) of a material. Ratio of the mass of a body to the mass of an equal volume of water at 4 °C or othe specified temperature. If a volume of a material weighs 8 pounds, and a equal volume of water weighs 10 pounds, the material is said to have a specific gravity of 0.8 (8 divided by 10 = 0.8). Insoluble materials with specific gravity of less than 1.0 will float in (or on) water. Insoluble materials with specific gravity greater than 1.0 will sink (or go to the bottom) in water. Most (but not all) flammable liquids have specific grav less than 1.0 and, if not soluble, will float on water - an important consideration for fire suppression and spill cleanup. |
| **stability** | An expression of the ability of a material to remain unchanged. For SDS purposes, a material is stable if it remains in the same form under expected and reasonable conditions of storage or use. Conditions such as temperatures above 150 °F or shock from being dropped that may cause instability (dangerous change) must be stated on the chemical's SDS. |
| **STEL** | Short-Term Exposure Limit. The maximum allowable average exposure level for a short period of time, usually 15 minutes. Also, see "PEL." |
| **stupor** | Partial or nearly complete unconsciousness. |
| **subcutaneous** | Beneath the skin. |
| **synonym** | Another name or names by which a material is known. Methyl alcohol, for example, is also known as methanol and wood alcohol. |
| **systemic** | Affecting the entire body. |
| **tachycardia** | Excessively rapid heartbeat. Pulse rate above 100. |

| Term | Definition |
|---|---|
| **target organ effects** | Chemically caused effects upon organs and systems such as the liver, kidneys, nervous system, lungs, skin, and eyes from exposure to a material. |
| **teratogen** | An agent or substance that causes physical defects in the developing embryo. |
| **tinnitus** | A ringing or singing sound in the ears. |
| **TLV** | Threshold Limit Value. A term used by ACGIH to express the airborne concentration of a material to which nearly all persons can be exposed day after day without permanent adverse effects. Since it is updated annually, this guideline level is often more current than the PELs listed in regulations. |
| **TLV - C** | TLV – Ceiling. The concentration that should not be exceeded even instantaneously. |
| **TLV - STEL** | TLV – Short - Term Exposure Limit. The average concentration over a short period, such as during peak or maximum generation of an airborne contaminant. The guideline limits such peaks to a maximum of four such periods per day, with at least 60 minutes between exposure periods, and provided that the daily TLV - TWA is not exceeded. |
| **TLV - TWA** | TLV – Time Weighted Average. The recommended guideline time- weighted average exposure limit for a normal 8-hour workday or 40- hour week. Also, see "TWA." |
| **toxic** | Having (a) an LD50 of 50-500 mg/kg when administered orally to albino rats weighing 200-300 grams each, (b) an LD50 of 200-1000 mg/kg when administered by continuous contact for 24 hours with the bare skin of albino rabbits weighing 2-3 kilograms each, or (c) an LC50 of 200-2000 ppm (gas or vapor) or 2-20 mg/l (mist, fume or dust) when administered by continuous inhalation for one hour to albino rats weighing 200-300 grams each. |
| **toxicity** | The sum of adverse effects resulting from exposure to a material, generally by the mouth, skin, or respiratory tract. For RCRA purposes, EPA may regulate solid or liquid wastes that exhibit certain specified characteristics of toxicity as hazardous wastes. |
| **treatment** | A chemical or physical process that makes the waste less hazardous or non-hazardous, or recovers materials. |
| **TSCA** | Toxic Substances Control Act. The federal environmental legislation, administered by EPA, for regulating the manufacture, handling, and use of materials classified as toxic substances. |
| **Term** | Definition |
| **TWA** | Time-Weighted Average. The method of averaging exposures to airborne concentrations of a material when levels vary, based on duration of exposures to those levels. For example, an exposure of some chemical at 100 parts per million for 2 hours and 0 parts per million for 6 hours for an 8-hour work day would be the first level times duration plus the second level times duration, divided by total work shift, i.e., (100x2+0x6) divided by 8 hours, or 25 parts per million. This is normally for an 8 hour work day, but other durations may apply as necessary. Used in conjunction with "PEL" and "TLV." |
| **UEL or UFL** | Upper Explosive Limit or Upper Flammable Limit. The highest concentration of a material in air that will produce an explosion or fire when it contacts an ignition source (high heat, electric arc, spark, or flame). A higher concentration of the material with a smaller percentage of oxygen or air may be too rich to be ignited. Care must be taken if using air or oxygen to dilute a high concentration too rich to burn, since at some point the mixture will fall within the explosive or flammable range and may be very hazardous. Also, see "LEL or LFL." |

| Term | Definition |
|---|---|
| **unstable** | Tending toward decomposition or other unwanted chemical change during normal handling or storage. |
| **urticaria** | Nettle-rash; hives; elevated, itching, white patches. |
| **UW APS** | University of Washington Administrative Policy Statements. Official UW policies, available at www.washington.edu/admin/rules/policies/APS/APSTOC.html. |
| **vapor density** | The weight of a vapor or gas compared to the weight of an equal volume of air: an expression of the density of the vapor or gas. Materials lighter than air have vapor densities less than 1.0. Materials heavier than air have vapor densities greater than 1.0. All vapors and gases will mix with air, but the lighter materials will tend to rise and dissipate (unless confined). Heavier vapors and gases are likely to concentrate in low places (along or under floors; in dumps, sewers, and manholes; in trenches and ditches), where they may create fire, explosion, or health hazards. |
| **vapor pressure** | The pressure exerted by a saturated vapor above its own liquid in a closed container. Vapor pressures reported on SDSs are in millimeters of mercury (mm Hg) at 68 °F (20 °C), unless stated otherwise. (Typically, chemicals with lower boiling points will have higher vapor pressures; e.g., hexane with a boiling point of 69 °C has a vapor pressure of 100 mm Hg, while 1,3-xylene with a boiling point of 139 °C has a vapor pressure of 10 mm Hg |
| **ventilation** | Circulation of air. |
| **vertigo** | A feeling of revolving in space; dizziness, giddiness. |
| **viscosity** | Measurement of the flow properties of material. |
| **Term** | Definition |
| **WAC** | Washington Administrative Code. The compilation of regulations written by State of Washington regulatory agencies. WACs can be reviewed online at apps.leg.wa.gov/wac/. Regulations about safety and health are written by Washington State Department of Labor and Industries (L&I), put into Title 296 and are also available at https://lni.wa.gov/safety-health/safety-rules/rules-by-chapter/. |
| **water reactive chemicals** | A chemical that reacts with water to release a gas that is either flammable or presents a health hazard. |
| **WISHA** | Washington Industrial Safety and Health Act. The legislative act that requires a state agency (L&I) to be responsible for drafting and monitoring compliance with safety and health regulations affecting employers and workers in Washington. |

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# APPENDIX C: TEMPLATES – LAB SPECIFIC INFORMATION

***Contents***

## A. LABORATORY-SPECIFIC INFORMATION

The following templates and examples can be used to note laboratory-specific information *required* to complete your lab's Chemical Hygiene Plan (CHP). These are in addition to the form at the front of the manual and sections can be downloaded from the EH&S website.

Your lab's CHP consists of the generic UW Laboratory Safety Manual, plus your lab's laboratory-specific information. These materials must be accessible to your workers at all times, and your workers must know where these materials are located.

If you use printed copies of your laboratory-specific information, you should file these pages in the front of the *Laboratory Safety Manual* for easy reference or maintain them in a location that everyone knows is the specified location of the laboratory-specific information for your Chemical Hygiene Plan (CHP). If you keep electronic copies of all or some of your laboratory-specific information, everyone in the lab must know current file location and how to access.

## B. LABORATORY FLOOR PLANS

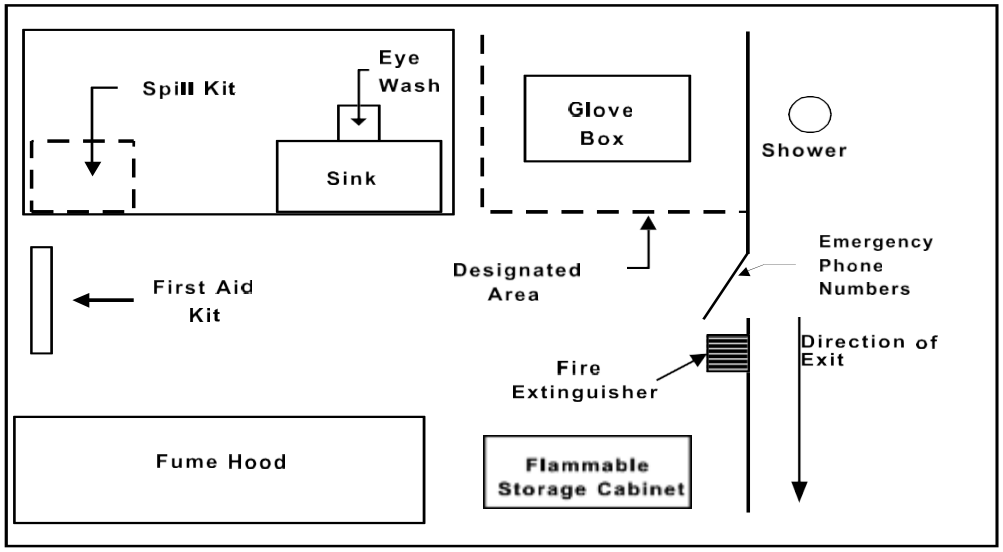
Create a floor plan for each room that is covered by this manual. Place a copy of the plans in the "*My Lab-Specific Information*" section of your manual and post them in the relevant room. Note the locations of any signs, safety equipment and process- related equipment that may be present. (Refer to example floor plan, Figure C-2). Templates are provided to create and print a lab floorplan template for your space; a multi-room floorplan template is also available:

**Floor Plan to Include**:

- Eyewash Stations
- Emergency Phone Number Signs
- Emergency Showers
- Direction of Exit
- Fire Extinguishers
- Gas Shut-Off Valves for Benches
- First Aid Kits
- Ventilation Systems
- Flammable Liquid Storage Cabinets
- Spill Kits
- Glove Boxes
- Electrical Panels/Circuit Boxes
- Any other specialized equipment or operation with safety implications.

*(*If select carcinogens, reproductive toxicants, select agents, highly toxic or highly dangerous chemicals are in use, a designated area must be specified. This area can be the entire laboratory, a fume hood, or portion of the laboratory.)*

*Figure C-1 Example Floor Plan*




## C.TRAINING DOCUMENTATION FORMS

Responsible Parties and laboratory supervisors are responsible for ensuring that all employees receive adequate training to understand the hazards present in their work area and the policies for working with them, including policies and practices for working alone. Trainees may include administrative personnel handling lab chemicals for tasks such as receiving, inventory, and stocking. Laboratory personnel must also receive training applicable to all UW employees, such as an orientation to the Accident Prevention Plan, the department's supplemental Accident Prevention Plan or Health and Safety Plan, the Fire Safety Evacuation Plan, Asbestos General Awareness, Violence Prevention, etc.

Complete training prior to assignments involving potential exposure to chemicals and hazardous materials. EH&S provides general training for most categories of hazards in the laboratory. Refer to the EH&S Lab Safety Training Matrix for guidance and training documentation.

Laboratory-specific training, including safety orientations, work policies, training on equipment and procedures, use of hazardous substances, and any other in-house training, be completed and documented for all personnel.

The following page (Figure C-2: Example Chemical Safety Training Log for Groups) shows an example form which could be used to document a training session. After being filled out, this form may be filed in the laboratory-specific information section of the LSM or in a department's filing scheme. If filed separately from the laboratory-specific information section, the filing location be noted in the laboratory- specific information section and available to all lab personnel.

Two forms are available to track individualized training:

The Safety Training for Laboratory Personnel matrix form can be used to identify EH&S training classes available based on an individual's duties and document completion. It can be found at: https://www.ehs.washington.edu/system/files/resources/ehslabsafetytrainmatrix.pdf.

The Laboratory-Specific Safety Training Record can be used to plan, track and document the laboratory-specific training received by a specific individual (Figure C-3 below). For your use, a PDF version of this form is available at: https://www.ehs.washington.edu/resource/lab-employee-safety-training- checklist-174.

## Example Chemical Safety Training Log for Groups

***Figure C-2 Example Safety Training Log for Groups***

| UW Chemical Safety Training Log | | | |
|---|---|---|---|
| PI/Supervisor: | | | |
| Department: | | | |
| Documentation includes formal and informal safety discussions, including meetings when the agenda includes any safety discussions. Log discussions on Personal Protective Equipment, ventilation systems, glove box requirements, specific chemical hazards, MSDS access, chemical storage plans, etc. Attach training outline and other reference materials useful for training new personnel. | | | |
| Date | Trainer | Trainees | Description of Safety Training |
| Ex. 1/21/17 | Roberta Rosen | Tim Hansen, John Peil | Protective glove selection, use, disposal when handling solvents |
| Ex. 2/12/17 | Dr. Albert Jones | Jerry Marshall, Roberta Rosen, April Shen | Hazards of new Montrose Model 550 GLC – outline attached |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
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| | | | |

***Figure C-3 Laboratory-Specific Safety Training Record***

**UW LABORATORY-SPECIFIC SAFETY TRAINING RECORD**

**Employee Name:** **Start Date:**

**PI /Supervisor Name:** **Lab location:**

## Chemical Hygiene Plan Trainings

Note: PIs, CHOs and any staff in a supervisory role are required to complete Laboratory Safety Compliance and Laboratory Safety Practices trainings. Document with EH&S trainings.

| Chemical Hygiene Plan Component | Done | Date |
|---|---|---|
| Orientation to the content and location of the:<br>• UW Laboratory Safety Manual<br>• Lab-specific Standard Operating Procedures (SOPs)<br>• Emergency contact numbers, including after-hours emergency contacts<br>• Other lab-specific information, including work policies | ☐ YES | |
| Methods for finding exposure limits | ☐ YES | |
| Location of Material Safety Data Sheets/Safety Data Sheets (MSDSs/SDSs) and other safety references | ☐ YES | |
| The hazards of the workplace and how to detect the presence or release of hazardous chemicals and the basic signs and symptoms of chemical overexposure | ☐ YES | |
| Requirements for Personal Protective Equipment (PPE) and how to select, don, remove, and maintain supplies | ☐ YES | |
| Chemical storage practices in the laboratory | ☐ YES | |
| Proper containment and disposal of all laboratory waste | ☐ YES | |
| Location of laboratory emergency equipment: emergency showers, eyewashes, first aid kits, spill kits, fire extinguishers, etc. | ☐ YES | |
| How to respond to spills, exposures, and other emergencies and report them in OARS | ☐ YES | |

## Chemical Safety Trainings

Note: All laboratory personnel, including students, are required to complete Managing Lab Chemicals training, including refresher training every three years. Document with EH&S trainings.

Is training for use of specific chemicals completed and documented on lab SOPs? ☐ YES ☐ NO

List chemical trainings below that are not documented on SOPs

| Name of Chemical | Policies and Practices Reviewed | Date |
|---|---|---|
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |

## Equipment Safety Trainings

Is training for use of specific equipment completed and documented on lab SOPs? ☐ YES ☐ NO

List specific equipment trainings below that are not documented on SOPs

| Name of Equipment | Policies and Practices Reviewed | Date |
|---|---|---|
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |

## Laboratory-specific Procedure Trainings

Is training for specific procedures completed and documented on lab SOPs? ☐ YES ☐ NO

List specific procedure trainings below that are not documented on SOPs

| Name of Procedure | Policies and Practices Reviewed | Date |
|---|---|---|
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |

## Additional Laboratory-specific Trainings (confined spaces, lockout/tagout, HIPAA, human subjects protections, etc.)

**Note:** trainings required for work and conducted by departments/entities outside of EH&S or UW can also be listed here

Is additional training for hazards or practices not listed in the previous sections completed and documented on lab SOPs? ☐ YES ☐ NO

List specific procedure trainings below that are not documented on SOPs

| Name of Training | Policies and Practices Reviewed | Date |
|---|---|---|
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |
| | ☐ YES | |

**After initial trainings have been completed, have the new employee sign and date this form and save it in your laboratory training records. Update as new trainings are completed.*

**Employee Signature**:_____ **Date**:_____

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# APPENDIX D - STANDARD OPERATING PROCEDURES (SOP) TEMPLATES

***Contents***

## A. LIST OF STANDARD OPERATING PROCEDURES (SOP) TEMPLATES

Template documents for SOPs are on the Chemical SOPs webpage. Contact EH&S at or call to 206.685.3993 with questions about SOPs, or if you would like an SOP reviewed.

## B. BLANK STANDARD OPERATING PROCEDURE (SOP) TEMPLATE FOR CHEMICALS

A blank SOP template is available in Word format on the Chemical SOPs webpage.

## C. FORMALDEHYDE STANDARD OPERATING PROCEDURE (SOP) FORM

A copy of the formaldehyde SOP template is available in Word format on the Chemical SOPs webpage.

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# APPENDIX E - CHECKLISTS

***Contents***

# A. EARTHQUAKE PREPARATION CHECKLIST FOR LABORATORY PERSONNEL

The following checklist is designed to assist University Department Chairs, Responsible Parties and laboratory supervisors and personnel perform earthquake self-assessments. Use this list of questions to identify situations that may pose a problem in the event of an earthquake.

## 1. Preparing for a Major Earthquake

**If an earthquake occurred right now, where would you go for protection?**

- Locate safe and danger spots in your area. Decide if you would go under a desk or table, in a safe corner, or out of the lab against a corridor wall.
- Consider flying glass hazards from windows and glass and falling hazards from light fixtures, books, pictures, and equipment when selecting safe spots.

**Do you know the evacuation routes from your building?**

- If you are unfamiliar with your evacuation route(s), refer to your department's Fire Safety Evacuation Plan (FSEP) or contact your evacuation warden or evacuation director. For further information on evacuation routes from your building, contact EH&S at 206.685.0341.
- Post a lab floor plan near laboratory exits that shows exit routes.
- Do not leave the building until the tremors have stopped.

**Where is the primary evacuation assembly point (EAP) for your building, department, or work unit? Where is an alternate EAP in case your primary EAP happens to be downwind of a chemical or gas release or otherwise unusable**?

- Check your departmental health and safety plan or FSEP for location(s) of EAPs.

**Are gas cylinders properly secured in an upright position?**

- Are pressure regulators removed and cylinder caps in place on cylinders not in use?
- Are two cylinder straps or chains securely fastened to the lab wall for each cylinder?

**Are chemicals stored properly?**

- Are chemicals recapped and returned to their storage cabinets immediately after use?
- Are chemical storage cabinets closed and latched? Are chemical storage cabinets secured to prevent tipping or movement?
- Are storage shelves equipped with lips or restraints to keep chemicals and glassware in place?
- Are waste and unwanted chemicals removed in a timely fashion?
- Are chemicals stored in secondary containment trays or tubs?

- Are non-compatible chemicals stored separately?

**Are fume hood sashes closed as far as possible to contain spills while still maintaining adequate ventilation rates?**

**Are heavy pieces of equipment and furniture that might block exit routes secured?** If your lab has only one exit, UW policy requires items be secure.

- **Are exits and aisle ways maintained, and free and clear of obstructions?** Avoid storing anything, even temporarily, that could impede a quick exit or cause injury.
- **Do you have equipment and/or processes that could be damaged or pose a fire or health hazard if the power goes out?** What contingency plans have been made to provide backup or emergency power to maintain critical systems?
- **Are safety systems (e.g., fire extinguishers, safety showers, eyewashes) accessible and in proper operating condition?** Does everyone in the lab know where they are and how to operate them?
- **Are chemical and biological spill kits available?**
- **Are food, water, flashlight, first-aid kit, radios and batteries available?**

## 2. Operations after a Major Earthquake

**After the shaking stops:**

- Assist injured or mobility impaired people in evacuating the building
- Turn off gas burners and the main gas supply valve to the lab
- Check quickly for fires, fire hazards, or spilled chemicals
- Close the lab door as you leave
- Bring emergency supplies (first-aid kit, flashlights, etc.) to the evacuation assembly point
- Report crucial items or hazards to the appropriate official at the evacuation assembly point
- Do not re-enter the building until the building has been declared safe for entry by the University's Applied Technology Council (ATC)-20 assessment teams or other trained professionals.

Depending on the circumstances of the earthquake, you may be asked to stay out of the building for a few minutes to a few days -- or indefinitely. Develop long-term plans in case you cannot re-enter your laboratory. Contact UW Emergency Management at **206.765.7192** for assistance in developing Business Continuity Plans. Here are some items to consider:

- Which experiments and data are your first priorities?
- Do you have plans for routine tasks, such as taking care of lab animals or making certain you have enough liquid nitrogen for freezers? (Remember that normal distribution systems may not work, so you should have your own supply.)
- Do you have backup copies of important data?

For free informational handouts on earthquake preparedness (including for home/family), call EH&S

Training at 206.543.7201. Also check the Office of Emergency Management webpage for more earthquake preparedness information.

## B. MOVING IN/NEW LABORATORY CHECKLIST

Contact labcheck@uw.edu to notify EH&S of your new space. Use this checklist as a tool to help you get started with health and safety requirements.

### 1. General Safety

- Visit the laboratory to determine if it will meet your needs, has been cleaned/decontaminated, and is in good condition. If the lab had prior tenants, it should have a Notice of Laboratory Moveout posted inside one of the doors. If it does not, contact your Building Coordinator.
- If previously occupied, have all of the hazardous materials been removed? If not, contact your Building Coordinator.
- Maintain accessibility to health and safety related documents, including Safety Data Sheets (SDSs), training records and your Chemical Hygiene Plan (the UW Laboratory Safety Manual plus Laboratory-Specific Information.)
- Keep areas uncluttered; maintain three feet of space in all aisles
- Do not block exits or safety equipment, such as showers and eyewash stations

### 2. Emergency Planning

- Know locations of emergency showers and eyewashes
- Know the emergency escape routes (contact your Building Coordinator for more information)
- Prepare and post a floor plan which includes direction of exit from the laboratory, locations of signs, safety equipment, and process-related equipment
- Post emergency phone numbers next to telephone and computer
- Obtain chemical spill kit, biohazard spill kit (as needed) and first aid kit
- Reserve an accessible area for spill kits and other emergency equipment
- Keep tall cabinets, filing cabinets and other furnishings away from doorways or secure them to the wall

### 3. Facilities/Equipment

- Check test dates on the fume hoods, biosafety cabinets, fire extinguishers, and safety showers. To update fume hoods and biosafety cabinets, contact EH&S at 206.543.9510. To update fire extinguishers and safety showers, enter work order through local Facilities Services procedures (refer to Appendix F, Lab Safety Manual, for Facilities Services.)
- To relocate or purchase a new biological safety cabinet (BSC), submit a *Request to Purchase or Relocate a BSC* form to EH&S. Refer to the Biological Safety Cabinet FAQ for details.
- Any new fume hoods and BSCs are required to be tested and certified by EH&S before research can start. Contact EH&S at 206.543.9510 to schedule a test.
- If this is a newly constructed laboratory or if you have purchased new laboratory

equipment, ensure that equipment has been certified for function before using chemicals, radioactive materials, or biological agents.

- If research involves work at BSL-3/ABSL-3 containment, contact EH&S at 206.221.7770 as soon as possible for facility authorization.
- If the lab does not have a fire extinguisher, request one through your local Facilities Services. (Refer to Appendix F, UW Lab Safety Manual for Facilities Services.)
- Ensure that gas cylinders are secured to walls or bench tops with two chains or straps. Complete a Facilities Services work order request to secure cylinders. (Refer to Appendix F, Lab Safety Manual for Facilities Services.).

### 4. Chemical Safety

- Assess storage capacity for hazardous materials. Obtain approved storage cabinets as needed for flammable liquids (including flammable liquid wastes) so that the amount of flammable liquid outside a cabinet is always less than ten gallons. Obtain storage cabinets for acids and/or bases.

Apply for a new hazardous materials permit through your local fire department if one has not already been obtained by the department for the lab. If you are not sure whether your lab has a permit, contact EH&S at 206.685.0341. **Fill out or update the Laboratory-Specific Information in this Manual, including:**

- Laboratory floor plans
- General laboratory safety rules
- Designations of individuals performing the following tasks:
  - Chemical Hygiene Officer
  - Maintaining first aid supplies
  - Maintaining chemical inventories
  - Performing certain safety protocols
- Any special instructions for receiving and storing hazardous materials
- Locations and contents of chemical spill kits
- Location of Emergency Plans
- Location of SDSs and other safety reference materials if stored separately from the Laboratory Safety Manual
- Operating procedures for equipment
- Training records (or location of same if stored separately from the Laboratory Safety Manual)
- Standard Operating Procedures (SOP) for hazardous materials
- Segregate and store your chemicals correctly. Refer to this manual and the EH&S website for more information.

Make sure your chemical inventory is entered in the UW MyChem system.

- Call 206.616.4046 to obtain a MyChem account or update your contact information and location if you are an existing PI. EH&S can transfer MyChem inventories to your

new location and help can be obtained by calling 206.616.4046.

- Call EH&S at 206.685.0341 to let them know that your inventory is new in MyChem or has been updated in MyChem. If necessary, EH&S will request building use and fire department permits, which must be applied for before occupancy.

For questions or assistance concerning MyChem, refer the MyChem webpage or contact MyChem support at mychem@uw.edu or 206.616.5835.

### 5. Biological Safety and Animal Research

- Register and obtain approval for your research with EH&S if your research involves hazardous materials in animal studies, biohazards, recombinant DNA, or clinical trials involving human gene therapy. To initiate this process, submit a Biological Use Authorization (BUA) application found online at www.ehs.washington.edu/biological/biological- research-approval. This process also initiates the Institutional Biosafety Committee (IBC) approval process.
- If your work involves animal research, submit an Animal Use Medical Screening Form.
- If your research requires work at Biosafety Level 3 (BSL-3) containment, notify EH&S at 206. 221.7770 for approval as soon as possible because of limited availability of facilities.
- If your research involves work with select agents, notify EH&S at 206.221.7770 for authorization instructions.
- Maintain a Biosafety Manual with laboratory specific information.
- If you are working with blood or other potentially infectious materials, you must be included in the University's Bloodborne Pathogens Program. This requires a site-specific Exposure Control Plan (ECP), annual training, and offering of hepatitis B vaccination. The UW core Exposure Control Plan is in the Biosafety Manual.
- Complete the Supplemental Form for Bloodborne Pathogens to complete your site specific ECP.

*For questions or assistance contact EH&S at 206.221.7770.*

### 6. Radiation Safety

- **New Responsible Parties:** Obtain an authorization to use radioactive materials. If this is a new location, contact EH&S Radiation Safety as soon as possible to evaluate any special needs and potential for air emissions.
- Amend an existing authorization when adding personnel or changing a radionuclide use.
- **Human Subjects**: Submit an application with EH&S to use radiation with human subjects.
- Make sure you have a way to keep radioactive stock solutions locked when not in use.
- Using radioactive materials may require additional constraints than those stated above (e.g., using iodine for labeling requires radioiodine hood and using large quantities of material may require dosimeters).
- Radiation producing devices, laser, and other non-ionizing radiation such as ultraviolet light, microwave radiation, radiofrequency: Contact Radiation Safety to register your

device(s) and for hazard evaluation.

- For questions or assistance, contact EH&S Radiation Safety at 206.543.0463.

### 7. Hazardous Waste

- Reserve areas in your laboratory for safe hazardous waste accumulation as appropriate.
- If you have hazardous waste routines update the contact information and location. Email chmwaste@u.washington.edu with your routine numbers and new information.

- **New Responsible Parties:** Consider obtaining hazardous waste routines for specific waste streams that you generate on a regular basis. Fill in the New Routine Collection request form online.
- For que*stions or assistance call EH&S Environmental Programs at 206.616.5835.*

### 8. EH&S Training

- The PI and all persons working in laboratory spaces must complete Managing Lab Chemicals training
- Assess additional training requirements for all members of the laboratory based on their role, responsibilities, and work using the Safety Training for Laboratory Personnel matrix.

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# APPENDIX F - CONTACTS FOR LABORATORY PERSONNEL

***Contents***

## A. CALLING FOR ASSISTANCE

If you need safety information or assistance, please review the following list for a number to call. This is not a complete list but does cover most types of health and safety concerns on campus. The underlined topics include web links in the electronic versions of this manual.

A list of EH&S contacts can be accessed on the EH&S website.

**IN AN EMERGENCY: *DIAL 9 1 1***

| ***Topic*** | ***Phone*** |
|---|---|
| Accident/Incident Reports | 206.543.7388 |
| Air Pollution | 206.543.7388 |
| Animals (sick/injured) | 206.543.7209 |
| Asbestos Safety | 206.543.7388 |
| Autoclave, Sharps and Biological Waste | 206.221.7770 |
| Biological Safety Cabinets | 206.543.3993 |
| Biological Safety | 206.221.7770 |
| Bloodborne Pathogens Program | 206.221.7770 |
| Bloodborne Pathogens Exposures | 206.685.1026 |
| Bothell Campus Info Line | 425.352.3333 |
| Alert System | |
| Emergencies | 9-1-1 |
| Facilities Services Work Request<br>Emergency: 425.352.5466 | |
| Risk Management / Worker's Compensation | 425.352.3637 |
| Safe Campus | 425.352.7233 |
| Safety Escort Service | 425.352.5359 |
| UWB Security and Campus Safety (safety@uwb.edu) | 425.352.5359 |
| Bothell Fire Department (Administration)<br>Station # 42, 10726 Beardslee Blvd.<br>Bothell, WA 98011 | 425.486.1678 |
| Building Evacuation Planning | 206.685.0341 |
| Building Repairs and Maintenance: Refer to *Facilities Services* | |
| Calibrations for Radiation Detection Instruments | 206.543.0463 |

| ***Topic*** | ***Phone*** |
|---|---|
| Chemical Hazards (Worker Right-to-Know) | 206.543.7388 |
| Chemical Inventories | 206.616.5835 |
| Chemical Spills | 206.543.0467 |
| Confined Spaces | 206.543.0469 |
| Cranes and Hoists | 206.543.7388 |
| Diving Safety (Research) | 206.221.7770 |
| Dosimetry Services | 206.543.0463 |
| Drug Testing | 206.543.7388 |
| Earthquakes | 206.685.0341 |
| Electrical Safety | 206.543.7388 |
| Emergencies | 9-1-1 |
| Emergencies, All Campuses | 9-1-1 |
| Fires, All Campuses | 9-1-1 |
| Harborview Medical Center | 3000 or 9-1-1 |
| UW Medical Center | 9-1-1 |
| Environmental Health & Safety (EH&S) | 206.543.7262 |
| Bothell Campus, EH&S Liaison | 206.543.0469 |
| Seattle Campus, Building and Fire Safety | 206.685.0341 |
| Seattle Campus, Campus Health Services | 206.685.1026 |
| Seattle Campus, Environmental Programs | 206.616.5835 |
| Seattle Campus, Radiation Safety | 206.543.0463 |
| Seattle Campus, Research and Occupational Safety | 206.221.7770 |
| Tacoma Campus, EH&S Manager | 206.616.0595 |
| Electromagnetic Radiation | 206.543.0463 |
| Ergonomics | 206.543.7388 |
| Explosion | 206.685.0341 |
| Facilities Services: | *Below* |
| Bothell Campus Work Request<br>Emergency: 425.352.5466 | |
| Seattle Campus Emergency Repair | 206.685.1411 |
| Seattle Campus Information | |
| Seattle Campus Central Zone | 206.685.8814 |
| Seattle Campus Health Sciences Zone | 206.543.3010 |

| ***Topic*** | ***Phone*** |
|---|---|
| Seattle Campus North East Zone | 206.685.8815 |
| Seattle Campus Outside Zone | 206.616.5042 |
| Seattle Campus South West Zone (includes HFS) | 206.543.5677 |
| Tacoma Campus<br>e-mail: facility@u.washington.edu<br>Emergency: 253.606.2908 | 253.692.5700 |
| Fall Prevention | 206.543.7388 |
| Fire Safety | 206.685.0341 |
| Fire Safety Equipment Repair (Fire Extinguishers, etc.) | Below |
| Bothell Campus Work Request<br>Emergency: 425.352.5466 | |
| Seattle Campus | 206.685.1411 |
| Tacoma Campus | 253.692.5700 |
| Fire/Building Code Consultations | 206.685.0341 |
| Food Poisoning | 206.543.7209 |
| Food Service Area | 206.543.7209 |
| Forklift Safety | 206.543.7388 |
| Freezer Purchase | 206.685.0341 |
| Fume Hood Monitoring and Use | 206.543.9510 |
| Fume Hood Maintenance/Repair | *Below* |
| Bothell Campus: Work Order Emergency: 425.352.5466 | |
| Harborview Medical Center | 206.731.3191 |
| Seattle Campus / South Campus | 206.543.3010 |
| Seattle Campus / Upper Campus | 206.685.1411 |
| Seattle Campus / UW Medical Center | 206.598.4645 |
| Tacoma Campus<br>Emergency: 253.606.2908 | 253.692.5700 |
| Gas Cylinder Leaks | 206.616.5835 |
| General Health and Safety Information | 206.543.7388 |
| Husky Health Primary Care Center | 206.685.1011 |
| Hazardous Materials Storage | 206.685.0341 |
| Hazardous Material | 206.685.0341 |
| Health/Safety Plans | 206.543.7388 |

| ***Topic*** | ***Phone*** |
|---|---|
| Hospital Health and Safety: | *Below* |
| UW Medical Center | 206.598.4645 |
| Harborview Medical Center | 206.731.8742 |
| Hospital Radiation Safety | 206.543.0463 |
| Indoor Air Quality (Odors) | 206.543.7262 |
| Industrial Hygiene | 206.543.7388 |
| Industrial Insurance Claim (Worker's Comp) – Risk Management | 206.543.0183 |
| Labor and Industry Inspections | 206.543.7388 |
| Laboratory Safety: General | 206.685.3993 |
| Lasers | 206.543.0463 |
| Lead Safety | 206.543.7262 |
| Lockout/Tagout | 206.543.7262 |
| Medical Surveillance | 206.221.7770 |
| MyChem | 206.616.4046 |
| Safety Data Sheets (SDSs) / Inventory | 206.616.4046 |
| Noise/Hearing Conservation | 206.543.7388 |
| Occupational Health Nurse (Medical surveillance) | 206.221.7770 |
| Occupational Health Nurse (Clinical/Consultation) | 206.598.4848 |
| Odors: Indoor Air Quality | 206.543.7262 |
| Personal Protective Equipment | 206.543.7388 |
| Pest Control | 206.616.1623 |
| Bothell Campus Work Request<br>Emergency: 425.352.5466 | |
| Seattle Campus, Off-Campus | 206.616.1623 |
| Tacoma Campus<br>Emergency: 253.606.2908 | 253.692.5700 |
| Physical Plant: *Facilities Services* | *Refer to Listings* |
| Police / Security | *Below* |
| Bothell Security and Campus Safety | 425.352.5222 |
| Harborview Medical Center Public Safety<br>Emergencies<br>Non-Emergency phone number: | <br>206.744.5555<br>206.744.3193 |
| Tacoma Campus Safety and Security Emergencies:<br>253.692.4888<br>E-mail: uwtsafe@u.washington.edu | 253.692.4416<br>Or #333 |

| *Topic* | *Phone* |
|---|---|
| UW Police Department<br>Emergency:<br>Non-Emergency phone number: | <br>9-1-1<br>206.685.8973 |
| Pressure Systems (vessels, cylinders, sterilizers, etc.) | 206.543.7262 |
| Radiation Safety | 206.543.0463 |
| Radioactive Orders/Deliveries | 206.543.0463 |
| Recycle Chemicals | 206.616.5835 |
| Respirator Selection, Training, and Fit Testing | 206.543.7388 |
| Safety | *Below* |
| Bothell Security and Campus Safety | 425.352.5359 |
| Harborview Medical Center | 206.731.8742 |
| Seattle General Campus, Health Sciences, Off-Campus | 206.543.7388 |
| Tacoma Campus Safety and Security<br>Emergency: 253.692.4888<br>E-mail: uwtsafe@u.washington.edu | 253.692.4416<br>Or #333 |
| UW Medical Center | 206.598.4645 |
| Sanitation | 206.616.1623 |
| Scaffold | 206.543.7262 |
| Seattle Campus Info Line | 206.897.4636 |
| Seattle Fire Department (Administrative offices) | 206.386.1400 |
| Security: Refer to Police / Security | *Refer to Listings* |
| Sharps Disposal | 206.221.7770 |
| Shipping & Transporting | *Below* |
| Biological/Infectious Waste | 206.221.7770 |
| Hazardous Materials | 206.616.5835 |
| Radioactive Materials | 206.543.0463 |
| Spills-Hazardous | *Below* |
| Biological | 206.221.7770 |
| Chemical - Advice | 206.616.5835 |
| Emergency Assistance | 9-1-1 |
| Laboratory Spills | 206.616.5835 |
| Radioactive | 206.543.0463 |
| Swimming Pools | 206.543.7209 |
| Surplus Chemical Exchange | 206.616.4046 |

| ***Topic*** | ***Phone*** |
|---|---|
| Surveys, Radiation Safety | 206.543.0463 |
| Surveys, Safety | 206.543.7262 |
| Tacoma Campus | *Below* |
| Alert | |
| Campus Safety and Security<br>Emergency: 253.692.4888<br>E-mail: uwtsafe@u.washington.edu | 253.692.4416<br>Or #333 |
| Campus Safety Escort | #333 |
| Facilities Services<br>Emergency: 253.606.2908<br>E-mail: facility@u.washington.edu | 253.692.5700 |
| Worker's Compensation / Risk Management | 206.543.0183 |
| Tacoma Fire Department (Administration) 901 S. Fawcett Ave.<br>Tacoma, WA 98402-5699 | 253.591.5737 |
| Training | *Below* |
| Health and Safety | 206.543.7262 |
| Radiation Safety | 206.543.0463 |
| Ultraviolet Light | 206.543.0463 |
| Waste Disposal – Hazardous | *Below* |
| Biological/Infectious | 206.221.7770 |
| Chemical Waste | 206.616.5835 |
| Mixed Waste | 206.616.5835 |
| Radioactive | 206.543.0463 |
| Sewer Disposal | 206.616.5835 |
| Sharps/Needles | 206.543.7388 |
| UW Info Line | 206.UWS.INFO<br>1.866.897.INFO |
| Water Quality | 206.543.7209 |
| Workplace Violence | *Below* |
| Bothell Campus Emergency Response | 9-1-1 |
| Other Actions, *Bothell Campus* | *Refer to Listings* |
| Seattle Campus Human Resources: Upper Campus | 206.543.2800 |
| Seattle Campus Human Resources: Medical Centers, Health Sciences | 206.744.9220 |

| *Topic* | *Phone* |
|---|---|
| Tacoma Campus, Emergency Response | 9-1-1 |
| Other Actions, Refer to *Tacoma Campus* | *Listing* |

## B. ONLINE SAFETY RESOURCES

| **EH&S General Resources** | |
|---|---|
| Accident Reporting | www.ehs.washington.edu/workplace/accident-and-injury-reporting |
| Forms | www.ehs.washington.edu/search?fulltext=forms |
| MyChem | www.ehs.washington.edu/chemical/mychem |
| Posters (workplace) | www.ehs.washington.edu/search?fulltext=poster |
| Research Planning | www.ehs.washington.edu/biological/biological-research-safety |
| Respiratory Protection | www.ehs.washington.edu/workplace/respiratory-protection |
| Safety Committees | www.ehs.washington.edu/workplace/health-and-safety-committees |
| Training | www.ehs.washington.edu/training |
| Waste Management | www.ehs.washington.edu/search?fulltext=waste+management |
| EH&S Manuals/Plans | www.ehs.washington.edu/workplace/safety-and-program-manuals |
| Biosafety Manual | www.ehs.washington.edu/resource/uw-biosafety-manual-4 |
| Field Operations Safety Manual | www.ehs.washington.edu/system/files/resources/uw-field-operations-safety-manual.pdf |
| Fire Safety & Evac Plan | www.ehs.washington.edu/fire-life/building-emergency-procedures-and-resources |
| Lab Safety Manual | www.ehs.washington.edu/resource/laboratory-safety-manual-510 |
| Radiation Safety Manual | www.ehs.washington.edu/resource/radiation-safety-manual-521 |
| **Other UW** | |
| Facilities Services | www.washington.edu/admin/facserv/ |
| UW Emergency Management | www.washington.edu/uwem/ |
| **Regulatory Agencies** | |
| EPA | www.epa.gov |
| Fire department | Refer to focus sheet for you jurisdiction at https://www.ehs.washington.edu/system/files/resources/FS_FDContactInfo.pdf |
| OSHA | www.osha.gov |

| | |
|---|---|
| WA Dept. of Ecology | www.ecy.wa.gov |

| | |
|---|---|
| **EH&S General Resources** | |
| WA Dept. of Labor & Indus | www.lni.wa.gov |
| **Government Resources** | |
| Centers for Disease Control and Prevention | www.cdc.gov |

| | |
|---|---|
| Department of Homeland Security | www.dhs.gov/index.shtm |
| Federal Emergency Management Agency (FEMA) | www.fema.gov |
| King County Safety | www.kingcounty.gov/safety.aspx |
| National Institute for Occupational Safety & Health | www.cdc.gov/niosh/homepage.html |
| National Weather Service | www.wrh.noaa.gov/sew/ |
| WA Dept. of Health | www.doh.wa.gov |
| WA Dept. of Labor and Industries | www.lni.wa.gov/ |
| WA State Emergency Management | https://mil.wa.gov/emergency-management-division |
| **Non-Governmental Organizations (NGOs)** | |
| American Conference of Governmental Industrial Hygienists | www.acgih.org |
| American Industrial Hygiene Association | www.aiha.org |
| American Red Cross | www.redcross.org |

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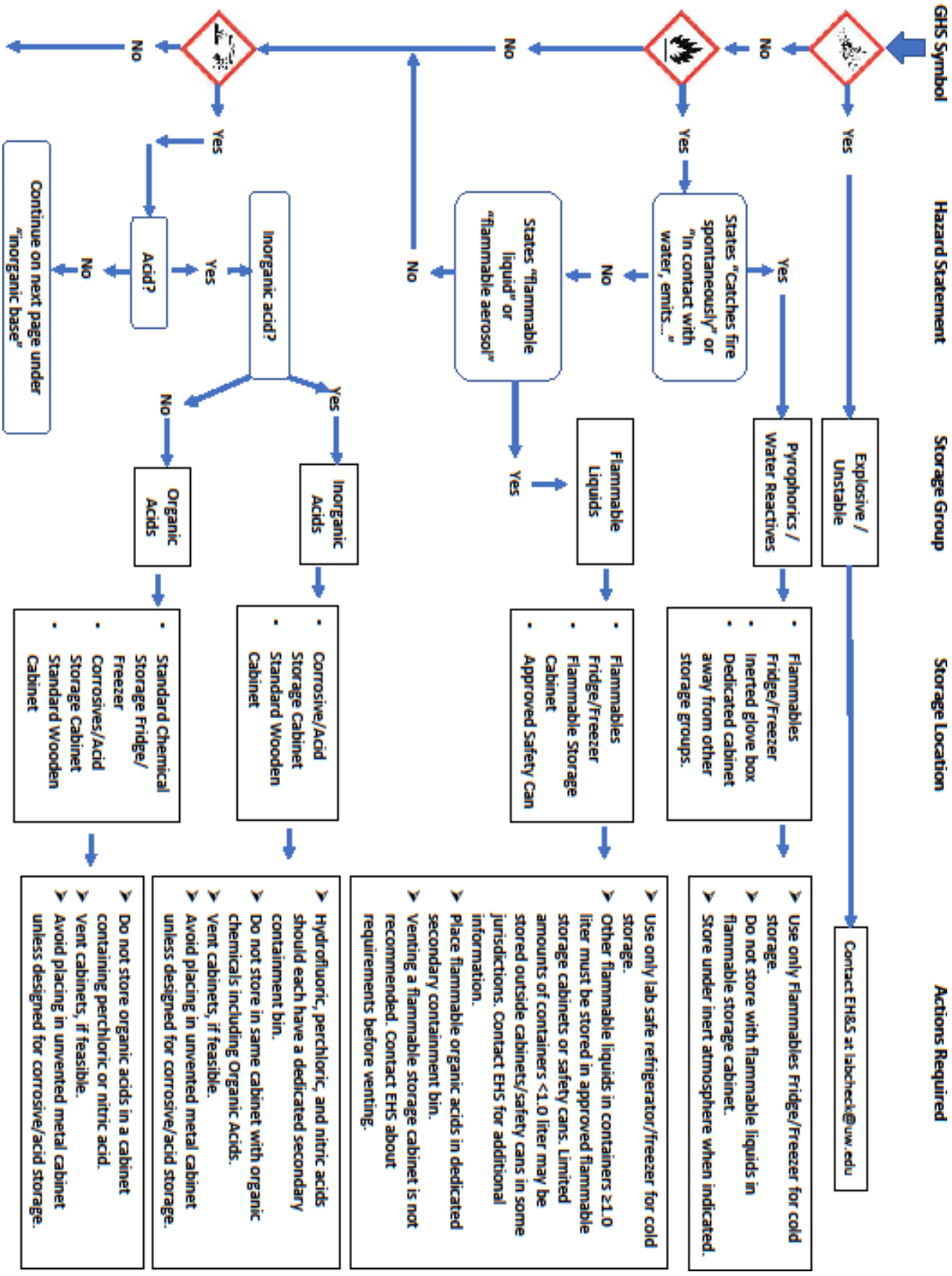
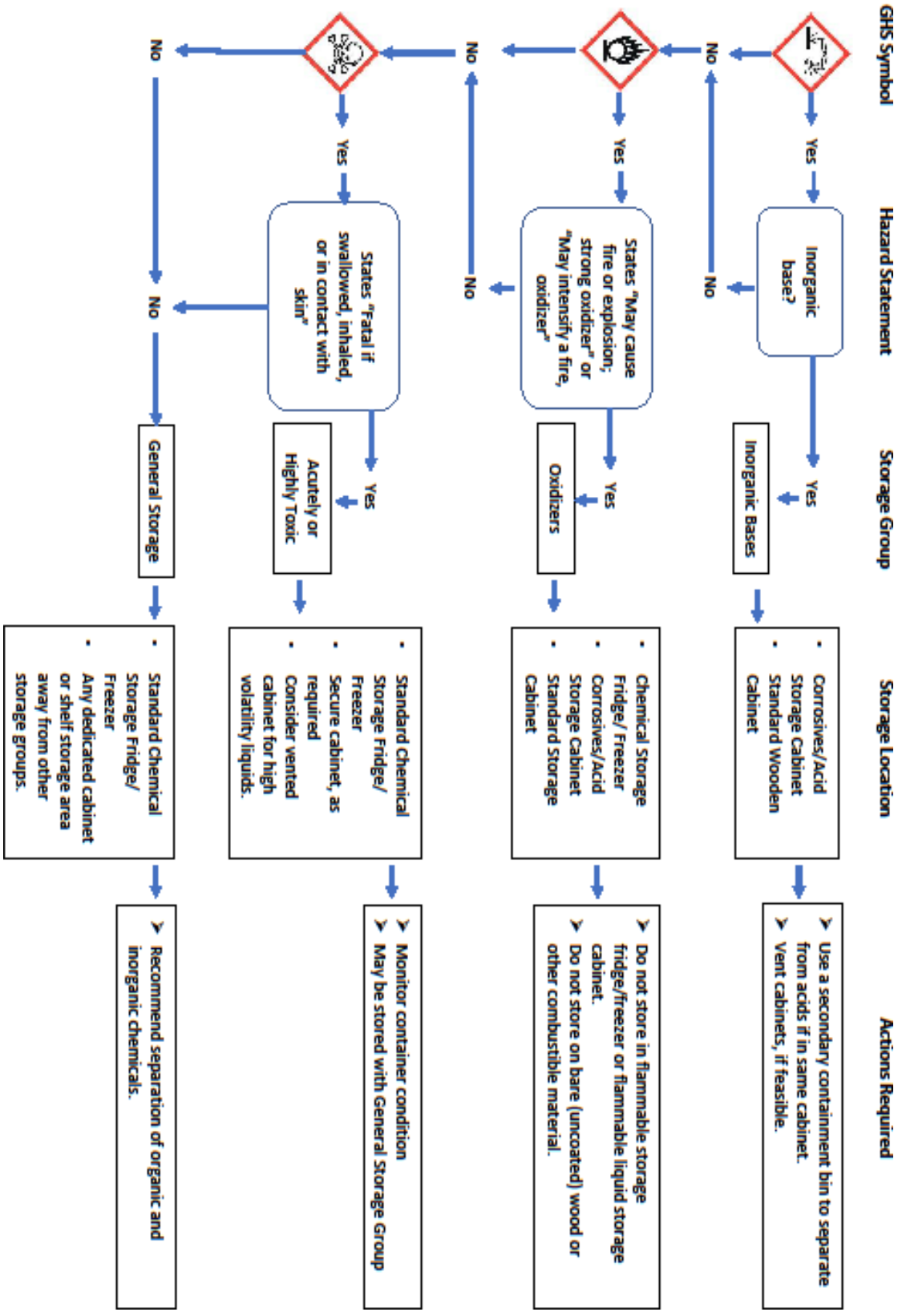
# APPENDIX G: CHEMICAL STORAGE GUIDANCE BASED ON GHS LABELS

***Contents***


GHS Symbol
Hazard Statement
Storage Group
Storage Location
Actions Required
Yes
No
Explosive / Unstable
Contact EH&S at labcheck@uw.edu
Pyrophorics / Water Reactives
States "Catches fire spontaneously" or "In contact with water, emits..."
Dedicated cabinet away from other storage groups.
Inert glove box
Store under inert atmosphere when indicated.
Use only Flammables Fridge/Freezer for cold storage.
Do not store with flammable liquids in flammable storage cabinet.
Flammable Liquids
States "flammable liquid" or "flammable aerosol"
Approved Safety Can
Flammable Fridge/Freezer
Flammable Storage Cabinet
Use only lab safe refrigerator/freezer for cold storage.
Other flammable liquids in containers ≥1.0 liter must be stored in approved flammable storage cabinets or safety cans. Limited amounts of containers <1.0 liter may be stored outside cabinets/safety cans in some jurisdictions. Contact EHS for additional information.
Place flammable organic acids in dedicated secondary containment bin.
Venting a flammable storage cabinet is not recommended. Contact EHS about requirements before venting.
Inorganic acid?
Inorganic Acids
Standard Wooden Cabinet
Corrosive/Acid Storage Cabinet
Do not store in same cabinet with organic chemicals including Organic Acids.
Hydrofluoric, perchloric, and nitric acids should each have a dedicated secondary containment bin.
Vent cabinets, if feasible.
Avoid placing in unvented metal cabinet unless designed for corrosive/acid storage.
Acid?
Organic Acids
Standard Chemical Storage Fridge/ Freezer
Corrosives/Acid Storage Cabinet
Standard Wooden Cabinet
Do not store organic acids in a cabinet containing perchloric or nitric acid.
Vent cabinets, if feasible.
Avoid placing in unvented metal cabinet unless designed for corrosive/acid storage.
Continue on next page under "inorganic base"


GHS Symbol
Hazard Statement
Storage Group
Storage Location
Actions Required
Yes
No
Inorganic base?
Inorganic Bases
Corrosives/Acid Storage Cabinet
Standard Wooden Cabinet
Use a secondary containment bin to separate from acids if in same cabinet.
Vent cabinets, if feasible.
States "May cause fire or explosion; strong oxidizer" or "May intensify a fire, oxidizer"
Oxidizers
Chemical Storage Fridge/ Freezer
Corrosives/Acid Storage Cabinet
Standard Storage Cabinet
Do not store in flammable storage fridge/freezer or flammable liquid storage cabinet.
Do not store on bare (uncoated) wood or other combustible material.
States "Fatal if swallowed, inhaled, or in contact with skin"
Acutely or Highly Toxic
Standard Chemical Storage Fridge/ Freezer
Secure cabinet, as required
Consider vented cabinet for high volatility liquids.
Monitor container condition
May be stored with General Storage Group
General Storage
Standard Chemical Storage Fridge/ Freezer
Any dedicated cabinet or shelf storage area away from other storage groups.
Recommend separation of organic and inorganic chemicals.