

Quick Start Guide: Completing Your CHP

September 2015

This Laboratory Safety Manual (LSM) is your reference for chemical health and safety and the policies affecting laboratories at the UW. It includes information on who checks the eyewashes, how to dispose of lab glass, how to use a fume hood and much more. Use the Table of Contents or do searches to find the information you need quickly.

Your LSM is part of what the Washington Department of Labor and Industries calls a “Chemical Hygiene Plan (CHP).” The CHP is required for all laboratories that use hazardous chemicals. EH&S developed much of your CHP for you – it is this LSM. *However*, you must add additional lab-specific information to have an effective plan, as described below.

For the best use of your LSM and to generate your lab’s Chemical Hygiene Plan:

1. Make sure that everyone who works in your laboratory will be able to access the LSM and the laboratory-specific information easily. If your lab’s CHP is to be maintained in electronic format, you can bookmark the PDF version of the LSM on the EH&S website at <http://www.ehs.washington.edu/manuals/lsm/index.shtm> and use electronic files to create your lab-specific information. If a paper copy is desired, current individual sections, excerpts, or the complete LSM can be printed from that web site. Whether you choose paper or electronic, what is important is that all lab staff can access the complete CHP while working.
2. Familiarize yourself with the Table of Contents of the LSM. Read parts of the LSM that you have questions about or are unfamiliar to you.
3. Laboratory-specific information is required and must accurately describe your lab. Lab-specific information is discussed in several sections of the LSM, including: SOPs (Section 6 and Appendix D), training (Section 7), and the lab floor plan (Appendix C). A template for gathering and organizing your lab-specific information is available in LSM Appendix C, pages 2 and 3. It can be generated as a Word document template (My Lab-Specific Information) from the EH&S web page.
4. Identify the responsible person, either the Principal Investigator or the Laboratory Supervisor, to be the Chemical Hygiene Officer (CHO) for the lab. Note that person’s name in the lab-specific information (My Lab) section of the CHP. This person must be familiar with the duties of the CHO as outlined in Section 1 of the LSM and enforce safety requirements in the laboratory.

If you have any questions about the LSM or the lab-specific information, contact EH&S by telephone at 206-543-7388 or by email to uwcho@u.washington.edu.

W UNIVERSITY *of* WASHINGTON

Laboratory Safety Manual

September 2015

W ENVIRONMENTAL HEALTH & SAFETY

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Log of Changes to the UW Laboratory Safety Manual (LSM) September, 2015

Date	Change Location	Description of Change
Sep 30, 2015	Section 1.C.n, Inspections	Noted that self-inspection checklists (in Appendix E) are replaced by a checklist available on the web
	Section 2.D, Chemical Storage	Revised to include best practices and reworded requirements for clarity
	Section 2.G.3, Highly Toxic Substances	Revised in accordance with Globally Harmonized System definitions
	Section 2.G.5, Hazardous Drugs	Added for consistency with new Washington rule, following paragraphs re-numbered
	Section 2.G.8, Compressed Gases, ..., Liquid Cryogen Containers	Completely updated and revised, and including additional information about cryogenic liquids
	Section 3.B.4, Toxic	Expanded toxic characteristic information to include EPA P-Listed Hazardous Wastes
	Section 3.B.6, Carcinogenic	Added information about disposal of hazardous, carcinogenic drugs
	Section 3.E.2 and 3.E.3	Included P-listed wastes disposal requirements
	Section 4.A Emergency Eyewashes and Showers, 4.B.1, Fire Extinguishers	Consolidated information from Section 9
	Section 4.C.1, Lab Caution Sign	Updated information about exterior door signs produced through MyChem, deleted redundancies
	Section 4.E.2.e, Grounding	Revised for clarity
	Section 4.G.2, Servicing of Lab Area or Equipment	Revised for clarity
	Section 5.B.2.d, Lab Coats	Revised for clarity, added laundry information
	Section 5.B.6, PPE Outside the Laboratory	Added paragraph describing means to prevent contaminants being carried out of lab
	Section 6.B, SOP Components	Revised for clarity
	Section 7.D, UW Office of Research – Research Required Training	Added section describing additional training requirements
	Section 8.A.7, Chemical Treatment Log	Corrected section, from Sewer Discharge Log to Chemical Treatment Log
	Section 9.A, Before an Emergency	Rewrote to limit discussion primarily to laboratory-specific situations
	Appendix E, Checklists	Replaced example self-inspection checklists with link to checklist used by EH&S for inspections
	Various locations	Updated links
Nov 14, 2014	Section 1.C.1.g	Added sentence on location of safety documents
	Section 1.C.1.n	Expanded information about the inspection process
	Section 1.C.2, Department Chair or Director	Added Dean, making it “Dean, Department Chair and Director”
	Section 2.A, Basic Lab Safety Practices	Added “Housekeeping” as paragraph 2.A.8

	Section 2.C.7, Compressed Gas Cylinder Procurement	Deleted paragraph about procedures to purchase highly toxic gas
	Section 2.D.1, Segregate Incompatibles	Revised to direct to EH&S web page to determine incompatibility; Moved other information to 2.D.2
	Section 2.D.2.a, Good Storage Practices	Revised wording about secondary containers; Added paragraphs for Refrigerators/Freezers Holding Flammables, and Storage on Door Shelves
	Section 2.D.2.b, Incorrect Storage Practices	Added paragraph 2.D.2.b.6), Storage In or Under Sinks
	Section 2.E, Chemical Labeling	Revised to address new requirements consistent with GHS (Globally Harmonized System)
	Table 2-9,	Changed title to Peroxide-Forming Chemicals
	Section 2.G.7.e, Regulators	Inserted new paragraph as 3) to forbid teflon tape except for special uses; Renumbered following paragraphs and revised them for clarity
	Section 3.F.3, Waste Treatment Log	Changed title to "Treating Hazardous Wastes"; Clarified need to inform EH&S about treated wastes
	Section 3.J, Sharps and "Lab Glass"	Revised to comply with disposal requirements and for clarity
	Section 5.B, Personal Protective Equip. (PPE)	Revised for clarity and to link to the EH&S PPE Assessment Guide
	Section 5.B.2.a, Inadequate Clothing	Changed title to Appropriate Clothing; Revised with updated clothing descriptions
	Section 10.B.1.d, EH&S	Revised to note that EH&S is advisor to move-out activities and not an approving authority
	Appendix A, 296-828 WAC	New WAC revision implementing GHS per OSHA
	Various locations	Corrected typographical errors
Sept 27, 2013	Preface	Revised cover page; Removed Director's letter
	Section 1.C.1	Responsibilities of the CHO re-organized for clarity and to address 29 CFR 1910.1450 Appendix A
	Section 2, Chemical Management	Revised concerning chemical storage quantity limits; Deleted Table 2-2; Updated Table 2-9 list
	Section 7, Training	Completely revised with links to web pages
	Section 9.B.3.d	Improved spill cleanup guidance
	Section 10.B.2.d	Changed citations to BioSafety Manual
	Appendix E, Checklists	Added new 2013 UW Inspection Checklist
	Various locations	Updated phone numbers and links
May 15, 2013	Various locations	Fixed links, HF Focus Sheet replaced Tip Sheet
Nov 29, 2012	Section 7, Training	Extensive changes throughout, changing wording to be consistent with regulations, added information about mandatory health and safety training
July 3, 2012	Section 4.C	Revised to describe new laboratory door signs.
	Section 7, Training	Revision changed and added mandatory classes, updated reference to Executive Order 55.
	Appendix D, Appendix H	Moved to EH&S web pages.
	Index	Deleted.
	Throughout manual, locations not marked	Made several editorial corrections and revised formatting to support an all-electronic manual. Updated EH&S office names.
September 1, 2009	All pages	Completely revised LSM



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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, which can be viewed at <http://www.washington.edu/admin/rules/policies/PO/EO55.html> .

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" or CHP. For UW chemical laboratories, the laboratory's chemical hygiene plan is created by combining laboratory-specific information and safety requirements with the generic UW Laboratory Safety Manual.

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

If the CHP is all electronic, personnel must know where the files are located and how to access them. They must have access to a computer and the files while working. For ease of electronic use, the UW Laboratory Safety Manual may be "bookmarked" in its entirety as a "pdf" file. Separate sections, templates, etc. can also be bookmarked from the EH&S web site, <http://www.ehs.washington.edu/manuals/lsm/index.shtm>. A caution with electronic information is that it must be obvious which files and documents are the current ones that must be used.

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 following the Quick Start page. The CHP must be accessible to all workers while at work; it cannot be locked in a supervisor's office. Laboratory-specific information such as chemical inventories, standard operating procedures, or material safety data sheets and other reference materials may be kept elsewhere if necessary.

A mixed paper/electronic version of the CHP may work best in your lab. A master index of where the parts of the complete CHP are located, identifying the current revision number or date for each part, should be easily available to all personnel at all times.

If some individuals want to keep personal copies of the UW Laboratory Safety Manual or the lab's standard operating procedures, all people must be aware of where the master CHP is located. Some information not directly associated with safety procedures and which might be troublesome to replace if lost, such as certifications that individuals completed safety training, may be kept separately in locked cabinets. That location should be identified in the laboratory-specific information section.

2. Regulations Pertaining to the Chemical Hygiene Plan

This generic Laboratory Safety Manual contains information applicable to all University of Washington 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 Washington Administrative Code (WAC) 296-828, Hazardous Chemicals in Laboratories, is the primary Washington regulation covering laboratories performing chemical manipulations; it may be also 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.

c. International Fire Code

The cities of Bothell, Seattle, and Tacoma require compliance with the International Fire Code (IFC) and additional local requirements. For assistance with compliance, contact EH&S at 206-543-0465.

d. Chemical Waste Management

The Laboratory Safety Manual 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. Information in Section 3 of the manual outlines the specifics of these requirements and describes how to safely dispose of chemicals.

e. US Department of Homeland Security Regulations

The United States Department of Homeland Security has developed Chemical Facility Anti-Terrorism Standards (CFATS) to implement the federal regulations at 6 CFR Part 27. These standards require the University to track and control specific chemicals of interest. The University's MyChem chemical inventory system as described in later sections of this manual is an important component in complying with the regulations.

3. Chemical Hygiene Plan Accessibility

The Chemical Hygiene Plan must always be accessible to laboratory employees and students at all times that the laboratory is occupied. If multiple rooms are included in the laboratory, the

plan must be available without having to get a key from another person. It must also be available on request to UW Environmental Health and Safety (EH&S) staff and Washington State Department of Labor and Industries representatives.

4. Other Plans and References

This Chemical Hygiene Plan/Laboratory Safety Manual is a part of a complete safety program. Other University documents impacting laboratory operations may include the department's Health and Safety Plan, the Emergency Evacuation and Operations Plan for the building, the Radiation Safety Manual, and the Biosafety Manual. External to the University, agencies providing grants may require additional plans and certifications.

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 Laboratory Safety Manual apply at all locations that serve as assigned workplaces and educational settings for University of Washington 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 of UW personnel.

Any laboratory which meets the definition of a chemical laboratory must complete a Chemical Hygiene Plan for the laboratory by adding laboratory-specific information to this manual. Laboratories which do not meet the definition of a chemical laboratory may refer to this manual for general safety information, but must comply with general industry regulations concerning chemical management.

1. Chemical Laboratory

A chemical laboratory is defined as an area (which can be a 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 mixing different hazardous chemicals in a variety of formulations, 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 considered to be those which present either a health hazard (such as an acute skin burn from a corrosive acid or a disease from a chronic, long term exposure) or could cause 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," or "Caution" or words to that effect, or the label could have some symbol which indicates a hazard. The chemical's Material Safety Data Sheet (MSDS) / Safety Data Sheet (SDS) may also indicate that the chemical has dangerous properties, could cause some disease or injury, or that personal protective equipment such as gloves are recommended when handling the chemical.

In addition to chemical hazards, this Laboratory Safety Manual 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 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, such as *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 UWNetID at <http://site.ebrary.com/lib/uwash/detail.action?docID=10465997> .

The EH&S web site (<http://www.ehs.washington.edu/>) contains information about environmental, health and safety policies and procedures for all UW work areas, not just laboratories. Specific policies and procedures are also addressed concerning the control of biological hazards in the UW Biosafety Manual (<http://www.ehs.washington.edu/rbsbiosafe/bsmanualindex.shtm>);

for research diving in the UW Scientific Diving Safety Manual (<http://www.ehs.washington.edu/manuals/divingsafetymanualuw.pdf>;

for LASER safety in the UW LASER Safety Manual (<http://www.ehs.washington.edu/manuals/rsmanual/lasermanual.pdf>)

and for the control of radioactive hazards in the UW Radiation Safety Manual (<http://www.ehs.washington.edu/manuals/rsmanual/index.shtm>).

C. RESPONSIBILITIES

1. Responsible Party

Each chemical laboratory must have a designated Chemical Hygiene Officer (CHO) who is knowledgeable about the laboratory's procedures, is actively involved or observant of those procedures being performed, and has the authority to enforce correct procedures.

In research laboratories, the CHO is generally the Principal Investigator (PI). If the PI has other commitments that prevent knowledge of the laboratory's day-to-day activities and assigns another person to be the laboratory's CHO, the PI is still considered the responsible party for the laboratory. In non-research laboratories, the responsible party may assign a laboratory supervisor, manager, or other senior-level person with authority familiar with activities within the laboratory to be the CHO. The CHO must be identified by name in the laboratory-specific section of the laboratory's CHP.

The CHO must ensure that laboratory-specific information is documented in the CHP and ensure that activities conducted within the laboratory are consistent with the CHP. To aid in compiling laboratory specific-information, a template and guides for noting laboratory-specific information are available in Appendix C of this manual and an electronic copy of the template is available at <http://www.ehs.washington.edu/manuals/lsm/lsmc.doc> . This template also makes it easier to identify the CHO by name and to remember when the annual review of the CHP should be accomplished.

The laboratory's responsible party 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) which include Personal Protective Equipment (PPE) requirements;
- Laboratory-specific topics covered in the laboratory's training program; and,
- Additional details specific to the laboratory and generally described on the laboratory-specific information template in Appendix C of the Laboratory Safety Manual, available at <http://www.ehs.washington.edu/manuals/lsm/lsmc.doc> .

b. Create a List of Chemicals Stored in the Laboratory

An accurate list of chemicals must be entered into the MyChem inventory management system and the list updated at least annually. Attach MSDSs/SDSs to the MyChem Inventory when received in the laboratory and not already online in MyChem. MyChem procedures are described in Section 2.B of the UW Laboratory Safety Manual.

c. Identify and Assess Hazards

The laboratory's responsible party must ensure all laboratory staff understand that new and changed procedures must be assessed for hazards. The laboratory's PI, 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 must be assessed.

If there are several processes to be assessed, they can be initially prioritized for assessment by knowing past accidents and whether any staff have troubles with a particular procedure, the processes in the laboratory which may be most easily compromised, procedures frequently performed or using large quantities of chemicals, and procedures involving particularly hazardous substances. Steps in the assessment include:

- 1) Researching chemicals and processes to be used;
- 2) Identifying and evaluating all types of hazards involved (some questions 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) Considering if additional hazards may be present when scaling up;
- 4) Selecting controls to adequately lower the perceived risks using the hierarchy of controls (starting with the most effective):
 - Eliminate hazardous substances and hazardous steps in the process if possible;
 - Substitute with lesser-hazard chemicals, smaller quantities, and safer processes if possible;
 - Implement engineering controls such as local ventilation or remote controls;
 - Implement administrative controls such as a "two person" policy during exceptionally hazardous processes; and,
 - Assess PPE requirements as a "last line of defense." (An assessment tool that may be used for additional guidance is available at <https://www.ehs.washington.edu/fsosurveys/ppetool.docx> .)
- 5) Ensuring emergency response situations have been addressed.

If the assessment results in there being requirements for controls, the requirements must be documented as described in the following paragraph. For best practices, it is recommended that the assessment be documented whether or not controls are required.

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 rules conspicuously posted in the laboratory or included in SOPs. Examples of general rules are in Section 2 of this manual and SOPs are described in Section 6. If an individual fails to follow the requirements, the laboratory's responsible party must initiate enforcement actions and document those actions.

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.7 and 4.C; labeling is described in Section 2.E of this manual.

f. Assess, Provide and Document Training

The laboratory's responsible party must ensure that training requirements for the individuals 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 selection and use of PPE. The department or others may provide information about the UW's general requirements such as emergency response procedures. Laboratory staff are responsible for training requirements concerning the materials and the processes conducted within the laboratory. The assessment and training must be documented.

Advice is available in Section 7 of this manual. A matrix that provides information about mandatory and recommended classes is available at <http://www.ehs.washington.edu/forms/ps0/ehslabsafetytrainmatrix.pdf>.

g. Ensure Staff Have Access to Safety Information

All those who work in areas with hazardous chemicals must have access to essential safety information while they are at work, including the CHP, MSDSs/SDSs, and the regulation (Washington Administrative Code (WAC) 296-828, Hazardous Chemicals in Laboratories). This information should be available in the laboratory space where work is being done.

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

h. Ensure Visitor Safety

- 1) Before starting their chemical use, visiting scientists 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) Other visitors such as maintenance staff, transportation services staff, and "open house" visitors must be protected from the hazards within the laboratory. For example, surfaces and equipment must be decontaminated and cleaned prior to allowing visitors to contact such surfaces and equipment. (Information about preparing equipment for servicing by maintenance personnel is in Section 4.G of this

manual and online at <http://www.ehs.washington.edu/forms/fso/lab equip.pdf> ; information about decontaminating equipment and facilities for disposal or lab relocation is in Section 4.H.)

i. Enforce Restrictions on Children

The laboratory must not be used as a child care area, in accordance with University of Washington Administrative Policy Statement 10.9 (which can be viewed at <http://www.washington.edu/admin/rules/APS/10.09.html>).

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 (<http://apps.leg.wa.gov/WAC/default.aspx?cite=296-125-030>). 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 (for more information, refer to <http://www.washington.edu/research/urp/students/pre.html>).

j. Enforce Restrictions on Pets

WAC 478-128 prohibits pets in all University facilities. Staff are prohibited from bringing pets into any University facility, including laboratories. (WAC 478-128 can be viewed at <http://apps.leg.wa.gov/WAC/default.aspx?cite=478-128> .)

k. Perform Annual Reviews and Update Documents

Annually, someone in the laboratory must check that changed information has been integrated into the CHP and should review that conditions have not drifted from a safety perspective by:

- Checking after September each year for any revisions to the Laboratory Safety Manual;
- Checking that actual laboratory procedures and conditions remain consistent with SOPs and other laboratory-specific information;
- Verifying that the MyChem chemical inventory is current including MSDS/SDSs and the names of responsible parties and contacts. Verify that a build-up of old chemical stock does not seem to be occurring in inventory; and,
- Reviewing internal inspection results and the condition of equipment used by laboratory staff to identify possible safety deficiencies, such as dirty or worn equipment, out-of-date fire extinguisher, or emergency shower inspections.

It is recommended that laboratory staff make any changes necessary and note the annual review (such as on a form similar to the template in Appendix C, page C-3) and maintain the documentation in the laboratory-specific information section of the CHP. If there are major changes during the year, it is recommended that laboratory staff 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 responsible party and to EH&S. It is recommended that incidents that do not result in significant injury or damage, but do result in learning experiences (often called "near-misses"), also be reported to the laboratory's responsible party and to EH&S.

Details for accident follow-up are provided in Section 9.B of this manual, including reporting requirements described in Section 9.B.1.b. If it is recognized that an SOP could be improved, update it prior to performing the procedure again.

m. Obtain and Post Hazardous Material Permits

Hazardous Material Permits must be obtained from your local fire department (Bothell, Seattle, or Tacoma). Sometimes, departments or building management will obtain permits for each of the laboratories. If they do not obtain them, the laboratory's responsible party must ensure the permit is acquired. This is most frequently a concern when a laboratory relocates or a new research project will involve highly hazardous chemicals. Contact your Departmental Safety Officer, Departmental Administrator, or EH&S at 206-543-0465 for advice.

n. Perform Inspections and Assist External Inspections

It is recommended that laboratory staff perform periodic self-inspections of the laboratory. The inspection checklist used by the EH&S survey team is available at <http://www.ehs.washington.edu/fsosurveys/prvaslbchklst.pdf> and can be augmented with additional items about laboratory-specific conditions.

Formal self-inspections using a checklist or informal/walk-through self-inspections could be performed semi-annually. If only a few problems are identified, the schedule may be changed to an annual basis (especially if laboratory personnel and procedures remain constant and few new pieces of equipment are obtained). It is recommended that all inspections have some type of documentation and that different people perform them to spread knowledge and to get different viewpoints.

If deficiencies are identified, they must be addressed. Documentation of the inspections and follow-up should be maintained for three years.

When notified of third party inspections (e.g., EH&S laboratory survey team), the responsible party should be responsive in scheduling and in providing laboratory-specific information as requested. Survey findings should be addressed in a timely manner. All laboratory staff should support the inspection as much as possible.

2. Dean, Department Chair and Director

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

a. Ensure Safety of 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, being familiar with departmental Health and Safety Plans and the activities generally being conducted, being aware of the general requirements in this manual and other safety and health requirements, and taking a reasonable person's approach in minimizing hazards and risks.

b. Enforce Laboratory Control Methods

Ensure that SOPs concerning use of particularly hazardous substances identify authorization requirements. For more information, SOP development is described in Section 6, recommended controls are provided in Sections 2.G and 9, and particularly hazardous substances are defined and examples are listed in Appendix H of this manual.

c. Maintain Records

Ensure that safety records are maintained as described in Section 8 (Record Keeping) of this manual.

d. Review Accidents

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

e. Review and Follow Up on Inspection Findings

Ensure that corrective actions are completed for safety deficiencies.

f. Ensure Appropriate Laboratory Closures/Moves

Ensure that laboratory closures or moves are done responsibly, as described in Section 10.

3. Employees/Students

Employees and students have a responsibility to:

a. Comply with Guidelines and Policies

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

b. Report Unsafe Conditions

Report unsafe conditions to your laboratory's Chemical Hygiene Officer, PI, a faculty member, your immediate supervisor, the Departmental Safety Officer, or to 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 on-line accident reporting system (<http://www.ehs.washington.edu/ohsoars/index.shtm>).

d. Use Personal Protective Equipment

Select, maintain and use PPE appropriately, consistent with your training. Students may be required to provide your own PPE, for use in academic laboratories and classrooms.

4. Environmental Health and Safety Department

EH&S is responsible for the following:

a. Develop the Laboratory Safety Manual

Produce and update the Laboratory Safety Manual, which provides the generic 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 the MyChem contacts with active inventories.

Assist laboratories, as needed, with the development of the laboratory-specific information required to complete their Chemical Hygiene Plan.

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

Act as a resource regarding laboratory safety issues.

d. Perform Laboratory Surveys/Audits

Conduct laboratory surveys and assist in implementation of self-auditing procedures.

e. Maintain an MSDS/SDS Database

Maintain an online Material Safety Data Sheet (MSDS)/Safety Data Sheet (SDS) database that is available to the campus community. The database system (MyChem) 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 Training

Develop and provide general training courses in laboratory safety.

5. UW Chemical Hazards Advisory Committee (CHAC)

The CHAC is composed of faculty and technical staff who are responsible for providing consultation, technical assistance, and recommendations to the Executive Director of Health Sciences Administration and the Director of EH&S relating to hazardous substances in laboratories. Programs which may be reviewed include development of the CHP, hazard communication, community right-to-know notifications, chemical safety, carcinogen/mutagen/teratogen safety, and hazardous waste management.

6. UW Chemical Hygiene Officer (UW CHO)

The Director of EH&S will appoint a University Chemical Hygiene Officer to assist the laboratory CHOs to interpret the policies and requirements in the Laboratory Safety Manual as needed and to recommend changes in policies and programs to the CHAC as needed. This individual can be contacted by emailing uwcho@u.washington.edu or by telephone to 206-543-7262.



Section 2 - Chemical Management

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A. BASIC LABORATORY SAFETY PRACTICES

1. 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 G later in this section). If you are working alone with lesser hazard chemicals, let personnel in other laboratories know of your presence or develop an accountability system with your supervisor or co-workers.

2. Prevent Chemical Exposure

Prevent skin contact with chemicals. For example, use appropriate personal protective equipment (PPE) (goggles, gloves, and/or lab coat per Lab Safety Manual Section 5.B) but consider it as “the last line of defense” and use other precautions, such as using 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.

Prevent inhalation of chemicals. For example, use a fume hood whenever handling volatile or aerosolized chemicals, even if they are of relatively low toxicity. Cap chemicals as soon as is possible. Limit the smelling of chemicals to the minimum amount necessary; only smell a chemical if no other method of identifying a chemical is available and just waft the air at the

container opening towards your nose. Investigate the source of unfamiliar odors in order to eliminate them.

Prevent ingestion of chemicals. For example, do not taste chemicals. Mouth suction must not be used to pipet chemicals or to start a siphon; instead, a pipet bulb or an aspirator must be used to provide suction.

Prevent injection of chemicals. For example, dispose of needles as soon as the injection is complete. Use needles with inherent safety devices that prevent inadvertent needle sticks. Dispose of sharps into appropriate waste containers and do not over-fill sharps containers. If operating a high-pressure system, never check for a pressure leak using your hands.

3. Washing Hands

Wash hands well with soap and water after removing gloves and before leaving the laboratory area. Never wash with organic solvents. (See Section 5.B Personal Protective Equipment and Appendix G Gloves for more information.)

4. Food and Drink

Food and drink consumption in the laboratory increase the chance of exposure to chemicals; consumables are prohibited from being stored, prepared, or consumed in laboratories that use chemicals.

a. Glassware/Utensils

Glassware or utensils that have been 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 must not be used for food or beverage storage.

5. Vacuum

Use extra care when evacuating air from glassware. Shield or wrap the glassware to contain chemicals and glass fragments should implosion occur. When possible use thick wall vacuum glassware.

6. Access to Emergency Exits and Equipment

Storage, even temporary storage, and equipment must not block doorways, corridors, aisles, and stairways, to assure unobstructed access to exits in the event of an emergency. Likewise, emergency equipment, such as eyewashes, deluge showers, fire extinguishers, and fire alarm pull stations, must be directly accessible.

7. Laboratory Signs

Laboratory signs must be posted as described in Section 4.C. These signs may provide information (e.g., emergency numbers), prohibit unsafe behavior or require protective measures, or designate locations of various supplies and equipment.

Magnetic or framed signs that can be easily moved 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.

8. Housekeeping

Laboratory bench tops and other work surfaces must be provide enough space to safely carry out 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 in the laboratory at all times:

- Flammable materials are kept away from ignition sources.
- Incompatible materials are separated .
- Emergency equipment and supplies (eyewash, shower, spill kit, and fire extinguisher) are readily accessible.
- Fume hoods are kept uncluttered.

Shelves, cabinetry, refrigerators and other storage equipment must be orderly and all chemicals and chemical waste properly labeled. Label information should be visible (including compressed gases). Storage on the floor should be limited, temporary in nature, and in accordance with this Safety Manual. Sinks should be typically clear of dirty glassware.

Surfaces must be promptly cleaned if contaminated with hazardous materials and periodically cleaned as needed. Garbage, recyclables, and surplus equipment and materials must be removed regularly.

Pneumatic and gas tubing, power, control and data wiring, must be routed so they are protected from physical damage, do not create a tripping hazard, and are adequately secured to appropriate infrastructure.

B. CHEMICAL INVENTORY AND MSDSs/SDSs

Laboratories must maintain chemical inventories in MyChem, the University of Washington's campus-wide chemical tracking system. MyChem is designed for use during emergency planning efforts and to help laboratories comply with federal, state, and local regulations. Chemical inventories, location contacts, and chemical specific hazard summaries are provided to emergency personnel so they know what chemicals may be involved in an accident and who to contact in the event of an emergency. Laboratories should use these chemical inventories to keep track of chemicals to avoid unnecessary purchases and to avoid leaving old or unneeded chemicals in storage.

Laboratory staff are required to maintain up to date chemical inventories in MyChem to facilitate compliance with Bothell, Seattle or Tacoma Fire Department Hazardous Material Storage and Use Permits (occupancy permits), EPA Community Right-To-Know reporting, and Department of Homeland Security chemical security requirements.

MyChem stores approximately 500,000 hazard summaries in the form of Material Safety Data Sheets (MSDSs) or Safety Data Sheets (SDSs). As the inventory is entered, the MSDS/SDS is attached and readily accessible. All employees should be able to readily access an MSDS/SDS for any chemical they are using.

1. Access to MyChem

For access to MSDS/SDSs, go to <http://mychem.ehs.washington.edu> and login using your UWNetID and password.

To request access to site-specific chemical inventories and the Chemical Exchange, send an email to mychem@uw.edu .

MyChem is easy to use, but if you have questions or desire additional information, a MyChem User's Manual is available on the MyChem web site (<http://mychem.ehs.washington.edu>). You may also phone EH&S at 206-616-4046.

Hands-on computer training is available for groups upon request. Contact EH&S at ehstrain@uw.edu or call 206-543-7201.

2. Conducting your Chemical Inventory

Personnel must inventory all chemicals found in the laboratory and specify the maximum amount normally found at this location. Dilutions and reagents prepared in the lab for further work do not need to be added to the inventory, but must have a container label applied unless the preparation will be all used or disposed that day. Review and update inventories annually and whenever there are significant changes in your chemical inventory, such as when you are moving a laboratory or starting a new project.

The "MyChem User Guide" contains an inventory worksheet to aid the inventory process. To view the "MyChem User Guide" log into MyChem (<http://mychem.ehs.washington.edu>) and select the "User Guide" from the menu options.

While conducting your inventory, examine containers for deterioration and integrity. Chemicals that are expired, in bad shape or no longer needed must be managed as hazardous chemical waste. For more information about chemical waste management, see Section 3 of this manual.

After completing the inventory, the Chemical Hygiene Officer should print two copies of the inventory from MyChem: one copy for the lab and one for home in case of an after-hours emergency in the laboratory.

3. Safety Data Sheet/Material Safety Data Sheet (SDS/MSDS)

Safety Data Sheets (SDSs) and Material Safety Data Sheets (MSDSs) are documents that describe the physical and health hazards of chemicals. Manufacturers of chemicals must provide SDSs/MSDSs for chemicals that they sell. Recent changes in the regulation require the manufacturers begin replacing MSDSs with the new SDS format. As a result EH&S will begin replacing the online MSDS with the SDS as we receive them. Although many SDSs/MSDSs have limited application in laboratories due to their orientation towards industrial use of large quantities of a chemical, they provide basic information that all persons using that chemical need to know.

MyChem is the University of Washington's centralized SDS/MSDS database for chemicals used by University personnel (see Section B.1, above). EH&S maintains the MyChem SDS/MSDS database.

Laboratory staff and students must have ready access to SDSs/MSDSs for all chemicals used in the laboratory. The department or laboratory may choose whether to maintain the SDSs/MSDSs in either electronic or paper format. The source of the SDS/MSDS is less important than the requirement that all personnel using chemicals or working around the chemicals must be able to demonstrate that they can retrieve the SDS/MSDS for a chemical within a short period (such as within five minutes). MyChem allows researchers to link to electronic SDSs/MSDSs directly, so is a suitable tool for fulfilling this requirement.

EH&S recommends laboratories maintain paper copies of SDSs/MSDSs for the hazardous chemicals most likely to spill and/or cause injury to someone. Having an SDS/MSDS immediately available when someone has been exposed to a hazardous chemical helps emergency personnel decide how to respond and treat that person.

Call EH&S at 206-616-3441 to request assistance locating or accessing MSDSs/SDSs during business hours. If the SDS/MSDS is online in the MyChem system, EH&S will email or fax a copy within a work shift. Chemicals that do not have an SDS/MSDS in the system will take

longer to research and obtain. After business hours, contact the UWPD at 206-685-8973; UWPD will contact an EH&S representative.

If an SDS/MSDS is received with a chemical shipment please maintain a copy in the lab, and send the original to EH&S (Box 354110, c/o SDS/MSDS Coordinator) for addition to the MyChem database.

C. CHEMICAL PROCUREMENT

Most chemical products can be purchased without restriction from suppliers through eProcurement (on-line ordering system) or through UW Purchasing Services. However, the following rules and guidelines apply to some 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.

If possible, hazardous chemicals should be received directly by the laboratory. If it is 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.

When you open a shipment, you should verify that the proper chemical was sent, that the container is intact, and that the label is legible. The date of receipt should be written on the container's label.

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 to see the pharmacy formulary list, go to <https://depts.washington.edu/drugsvcs>. If you do not know exactly what is needed, 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. If you wish to order a controlled substance through Drug Services, a current Controlled Substances Registration Certificate must be faxed or mailed to Drug Services before an order can be filled.

Controlled substances must be stored in a locked cabinet with limited access. A perpetual inventory must be maintained and the inventory forms used must meet DEA and State regulations.

Expired or waste (undesired) drug(s) must be kept secure in a locked cabinet in a separate container properly labeled for content, and inventoried until disposal. Drug Services will provide the contact information of DEA-licensed reverse distributors who must be used for disposal. For more information on procurement or DEA-licensed reverse distributors, contact Drug Services (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 at <https://f2.washington.edu/fm/ps/buying/alcohol> . Instructions for maintaining accountability for tax-free ethyl alcohol are in Administrative Policy Statement (APS) 15.1 at <http://www.washington.edu/admin/rules/APS/15.01.html>.

5. Radioactive Materials

The State of Washington Department of Health, Division of Radiation Protection, licenses radioactive materials use. Using radioactive materials requires the prior approval of EH&S. Orders for radioactive materials must be placed through the UW Purchasing Department.

6. Highly Dangerous Materials

Materials that are extremely hazardous to property, health or the environment (explosives, pyrophoric materials, highly water reactive chemicals, and highly toxic gases, for example) must 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 and local amendments. See Section G: Special Chemical Hazards, below, for examples. Contact EH&S at 206-543-0465 for more information.

7. Compressed Gas Cylinder Procurement

Only order the amount of gas that you need. Some gas suppliers will not take returns of partially full or empty cylinders or containers.

Whenever possible gas cylinders should be purchased through the preferred supplier, Praxair, to ensure that the supplier has a cylinder return authorization program. Please refer to the UW eProcurement web site <http://www.washington.edu/admin/stores/eprocurement> and specifically at https://www.washington.edu/admin/purchstores/home_commodity/comp_gases.html .

Additional information is available on the EH&S web page <http://www.ehs.washington.edu/fsohazmat/gascylinders.shtm> .

If a different vendor must be used 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.

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, see the MyChem website at <http://www.ehs.washington.edu/epomychem/index.shtm>.

D. CHEMICAL STORAGE

1. Evaluate Chemical Hazards for Storage

The hazards due to the reactions between incompatible chemicals are many:

- 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 Safety Data Sheet (SDS) or Material 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

The first (number one) consideration for storage is the flammability characteristic of the material. If the chemical is flammable, it should be stored in a flammable cabinet. (If the total for flammables exceeds the quantity limits in paragraph 2.D.3 below, they must be stored in a flammables cabinet.)

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 (polymerization, for example). Isolate explosives.

c. Corrosivity

Review the corrosivity of the material and store accordingly.

d. Toxicity

Finally, review the toxicity of the material, with particular attention paid to regulated materials (this may mean that certain chemicals will be isolated within a storage area). 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. Ideally, practices will include:

- Provide an appropriate storage place following guidelines in Table 2-1 for each chemical and return the chemical to that location after use;
- Incompatibles must not be stored together; refer to <http://www.ehs.washington.edu/fsosurveys/chemcompat.shtm>, the Chemical Compatibility Chart;
- Store in compatible containers, and use compatible tubing and reaction vessels;
- Avoid storing chemicals on bench tops, except for those chemicals being currently used;
- Avoid storing chemicals in laboratory hoods, except for those chemicals being used currently;
- Store volatile toxics and odoriferous chemicals in a ventilated cabinet, if available;
- Do not expose stored chemicals to heat or direct sunlight;
- Store heavy bottles on lower shelves;
- Store corrosives below eye level;
- Containers of chemicals must be capped when not in use; make sure that caps on containers are secure; replace damaged caps;
- If a chemical does not require a ventilate cabinet, store it inside a closable cabinet or on a shelf that is anchored and that has a lip to prevent containers from sliding off;
- Chemicals (except cleaners) should not be stored under the sink, near the sink or in the sink, to minimize the chance of accidents and improper discharges to the sanitary sewer;
- Do not store chemicals in hallways, corridors or exit ways;
- Use secondary containment to prevent incompatible chemicals from mixing and reacting with each other if they must be stored adjacent to each other on a benchtop;
- Use secondary containment or spill control (such as placing the container on an absorbent pad) is generally required for containers on the floor;
- Particularly hazardous substances (highly dangerous or toxic chemicals, select carcinogens, mutagens, and teratogens) should be stored together if compatible. Signs should be posted indicating their location and unique hazards.
- 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 wastes following the same guidelines as above. Containers must be labeled with a completed University of Washington 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, see Section 3 of this manual.
- Use properly designed refrigerators or freezers for storing volatile flammables which are to be stored cool. The refrigerator/freezer must be certified by the manufacturer for flammable materials storage. More expensive, "explosion-proof" appliances are usually not required for the typical laboratory setting. See the EH&S website at <http://www.ehs.washington.edu/fsofire/flamfrig.shtm> for additional information;
- If containers are placed on 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.

Table 2-1 Chemical Storage Recommendations

Flammables.	Store in approved safety cans or cabinets. Do not store incompatible materials in the same cabinet. Keep away from any source of ignition: heat, sparks, or open flames. Flammable solids should be segregated from flammable liquids; also see section D.3 below.
Acids	Do not store with flammable solvents or combustibles. 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 from everything, including each other.
Bases	Store in corrosives cabinet, or on protected shelving away from acids. Segregate inorganic from organic bases.
Light Sensitive Chemicals	Store in amber bottles in a cool, dry, dark place.
Nitrated compounds	Nitrated compounds can be considered explosive; special care and handling may be required. Also see section G.2.a below.
Oxidizers	Store in a cool dry place away from flammables and reducing agents.
Peroxidizable Chemicals	Store in airtight containers in a dark and cool place. Most peroxidizable compounds are flammable and should be stored in a flammable liquid storage cabinet or room. Label containers with receiving and opening dates. Test for the presence of peroxides at least every six months. Discard before exceeding expiration date. Also see section G.2.b below.
Pyrophoric Substances	(Materials that will react with the air to ignite when exposed, e.g., tert-butyl lithium.) Store in a cool dry place, making provisions for an airtight seal. Also see section G.1.d below.
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. Also see section G.1.a below.
Water Reactive Chemicals	Store in a cool dry location away from any water source, including sprinkler systems. Have a Class D fire extinguisher available in case of fire. Also see section G.1.e below.
Compressed gas containers	Store in a cool dry place, preferable outside of the building, and secured with chain. Separate flammables and oxidizers by 20 feet or a 1-hour rated fire wall.
General chemicals	Store on laboratory benches or shelves with like chemicals.

3. Chemical Storage Quantity Limits

a. Control Zones

Chemical quantities in most University buildings are limited by the local fire code, which is based on the most recent International Fire Code (IFC) adopted by the local jurisdictions. (Note: Local amendments to IFC have been made by Bothell, Seattle, and Tacoma Fire Departments.) Limits by hazardous material classification apply to a control zone 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 in approved cabinets. Buildings under newer codes have

reduced limits in control zones above the second floor, and 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 can be aided by maintaining an accurate chemical inventory in MyChem. To assure compliance with the IFC, contact EH&S at 206-543-0465.

b. Flammable Liquids in Basements

Flammable liquids are also limited in basement rooms to comply with the International Fire Code. Aggregate storage quantity in basement areas is limited to about half the amount of an equivalent above grade area. Us MyChem or confer with EH&S to determine if you are exceeding maximum allowable quantities.

c. Additional Requirements

In a laboratory, a maximum of 10 gallons of flammable liquids, in approved containers, may be stored outside of a flammable liquid cabinet. See the following table, Table 2-2, Approved Flammable Liquid Storage Containers, for container types and limits (Reference: NFPA 30, Table 9.4.3). Flammable liquid containers larger than 5 gallons are not permitted in laboratories without specific approval.

Table 2-2 Approved Flammable Liquid Storage Containers

Container Type	Flammable Liquids			Combustible Liquids	
	Class I-A	Class I-B	Class I-C	Class II	Class III
	Flash Point < 73 °F Boiling Point < 100 °F (Ethyl ether)	Flash Point < 73 °F Boiling Point ≥ 100 °F (Hexane)	Flash Point ≥73 °F and < 100 °F (Diesel fuel)	Flash Point ≥ 100 °F and < 140 °F (Mineral spirits)	Flash Point ≥ 140 °F (Kerosene)
Glass	0.5 L (1.05 pt) *	1 L (1.05 qt) *	5 L (1.3 gal)	5 L (1.3 gal)	20 L (5.3 gal)
Metal	5 L (1.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)
Rigid Plastic IBCs (UN 31H or 31H2)	0	0	0	3000 L (793 gal)	3000 L (793 gal)
Composite IBCs w/flexible inner receptable (UN31HZ2) and Non-bulk Bag-in-Box	0	0	0	0	0
Polyethylene UN 1H1	5 L (1.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	450 L (119 gal)	450 L (119 gal)
Safety Can	10 L (2.6 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)	20 L (5.3 gal)
* Containers may be up to 5 Liters for reagents of Analytical Purity Grade or High Grade.					

E. CHEMICAL LABELING

1. Original Container

The label on an original container must be legible and be written in English. It must include the chemical/product name as shown on the MSDS/SDS and the manufacturer's name and address. Do not accept materials if the label is illegible or missing required information.

Beginning on June 1, 2015, 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 (<http://app.leg.wa.gov/wac/default.aspx?cite=296-901-140>). (Suppliers may still ship "old-style" labels until December 1, 2015.) There are six required elements after those dates:

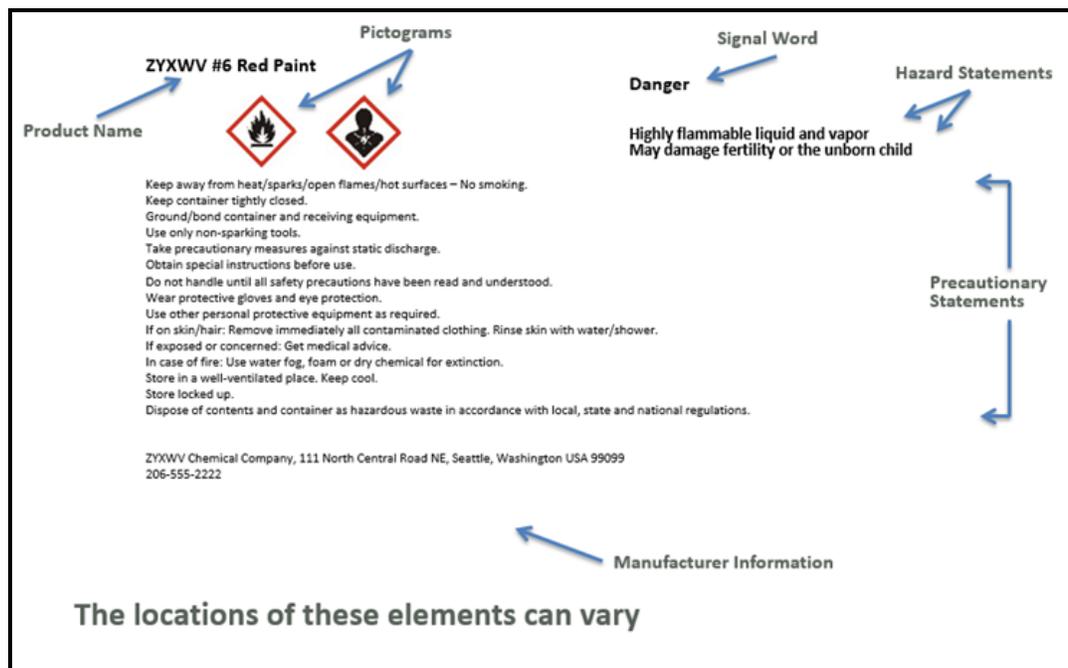
- Product name
- Manufacturer's name and contact information
- Signal word (e.g., danger, warning or no signal word)
- Hazard statement(s) (e.g., toxic if inhaled, combustible liquid)
- Pictogram(s)
- Precautionary Statements (e.g., keep container tightly closed)

An example label is shown below in Figure 2-1, Example of Original Label.

Avoid damaging the original container's label if at all possible. If a container label becomes illegible, replace the label. The replacement label must include the six required elements to be in compliance with GHS rules.

Contact EH&S at 206.543.7388 or uwcho@uw.edu as needed 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 will be emptied before the end of the work shift and be used by only one person.

If a preparation or working solution will be kept for a longer period or be used by others, 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 also “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 and the hazards can be obtained from the SDS/MSDS, but dilutions and reactions may change the hazards and their severity. It is best practice to also label the preparation with the date of preparation and preparer’s initials or name.

Your department may require a specific type of label. If so, describe 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, or color or numeric codes cross-referenced on a chart, or room diagrams identifying locations of the chemicals and hazards.

b. Additional Label Required for Peroxide-Forming Chemicals

Label chemicals that form peroxides with the date the container was first opened, using the label (UoW 1716) shown below.

Figure 2-2 Peroxide Label (UoW 1716)

UoW 1716 (10/07)

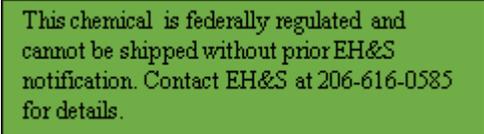
CAUTION PEROXIDE FORMING CHEMICAL	
Date Received ___/___/___	INHIBITOR ADDED <input type="checkbox"/> Yes <input type="checkbox"/> No
Date Opened ___/___/___	Type _____
Date Expires ___/___/___	
Limited shelf life. Store tightly closed away from light and heat. See UW Peroxide Guidelines or call 206-616-0595 for more information.	
Test Date _____ Peroxide _____ Tester _____	
Test Date _____ Peroxide _____ Tester _____	

<http://www.ehs.washington.edu/forms/epol/peroxideguidelines.pdf>

General requirements for handling chemicals that form peroxides are described later in this section in paragraph G.2.b.

c. Additional Label Required for CFATS Chemicals

Label chemicals listed in the Chemical Facility Anti-Terrorism Standard (CFATS) with a warning label as described in Section G.9.b below to remind workers that the substances are regulated and cannot be shipped off campus without prior EH&S notification.

Figure 2-3 Do Not Ship Label

This chemical is federally regulated and cannot be shipped without prior EH&S notification. Contact EH&S at 206-616-0585 for details.

Find the list of chemicals requiring this label in Section G.9.a.

d. Labeling Waste Containers

Waste containers must be labeled following guidelines in this manual in 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 wastes.

For radioactive waste, see Section 14 of the UW Radiation Safety Manual (<http://www.ehs.washington.edu/manuals/rsmanual/14waste.pdf>). For biological waste, see section 4.F (http://www.ehs.washington.edu/rbsbiosafe/BSM_Sec4.pdf) of the UW Biohazard Manual.

F. TRANSPORTING CHEMICALS

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 gloves must be worn, either be escorted by another person to open and close doors and press elevator buttons or remove the glove from one hand and use it to open doors while holding the chemical in the other hand.

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 should be clean enough that it could be handled without the need for protective gloves.
- 3) Chemical bottles must be labeled and should be 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 bottle carriers or larger containers and surrounded by vermiculite or other absorbent material.

- 5) A lecture bottle should be moved in a manner that protects the valve. Larger gas cylinders must be moved using precautions listed in Section G.8.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 cabs 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. The person must also have a spill kit that can handle the spill of those chemicals.
- 2) The exterior of the containers to be moved should be clean enough that they could be handled without the need for protective gloves.
- 3) Chemical containers must be labeled and securely closed. Lecture bottles should be packed in a manner that protects the valve.
- 4) 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.
- 5) 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 to prevent the bottles from rattling against each other.
- 6) 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.
- 7) For laboratory moves across campus, EH&S can arrange for a contractor to pack and move your chemicals for you, 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

EH&S is required to notify the Department of Homeland Security if you ship certain listed substances governed by the Chemical Facility Anti-Terrorism Standards (CFATS). Please see Section G.9 below to learn more and to see a list of the 22 “do not ship” chemicals.

a. Vehicle Use

You cannot transport hazardous chemicals in your personal vehicles without prior authorization by the UW. You can transport certain hazardous materials in a UW owned and operated Motor Pool vehicle. For more information or for authorization, call 206-616-5835 or email chmwaste@u.washington.edu. If you are transporting chemicals for a move, please see 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 (see Section F.2.c, following). This includes situations when you use a commercial contractor (FedEx, United Parcel Service, Yellow Freight, etc) to transport a

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.

c. Training

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 class *Shipping Hazardous Materials*. Class times and registration can be found on our website at <http://www.ehs.washington.edu/psotrain/corsdesc.shtm>.

d. Laboratory Moves

EH&S will arrange to have a contractor package your chemicals and transport them to your new location if off-campus. There are some materials that they cannot transport (temperature restrictive materials, DEA regulated materials, and radioactive, infectious or explosive materials). See Section 10.B.2 for more details. For more information, call 206-616-5835 or email chmwaste@u.washington.edu.

G. SPECIAL CHEMICAL HAZARDS

Personnel need to take special precautions with chemicals that are reactive, explosive, highly toxic, carcinogens and reproductive hazards, sensitizing or allergenic, synthesized chemicals, in compressed gas cylinders or at high pressure, that present exceptional flammability hazard, or have additional specific requirements due to federal regulations. If the degree of hazard is serious enough, the chemical is classified as a particularly hazardous substance. Criteria for particularly hazardous substances are shown on the EH&S web page

<http://www.ehs.washington.edu/manuals/lsm/lsmh.shtm> , and expanded precautions for use include such things as:

- Improving the security and integrity of the chemical storage,
- Reviewing proposed procedures by another PI,
- More intensive training on the chemical's hazards and the equipment to be used when handling the chemical,
- Requiring increased proficiency before any particular individual may perform the procedures be demonstrated and documented,
- Requiring a second lab worker be in the lab in case of emergencies,
- Ensuring all safety measures are included in the SOPs, and,
- Checking that any additional measures for shipping such materials have been addressed.

1. Reactive Chemicals

A chemical is a 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 which have an NFPA rating of "3" or "4" for Reactivity are also considered to be particularly hazardous substances due to being highly dangerous, and the extra precautions taken as described in the opening paragraph of Section G above need to be documented in your SOPs.

a. Compounds That Generate Toxic Gases

Some compounds that contain sulfide or that 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. Examples are shown in Table 2-3.

Table 2-3 Toxic Gas Generators

Copper (II) cyanide	Mercury (II) cyanide	Sodium cyanoborohydride
1,4-Dicyanobutane	Methyl sulfide	Sodium dicyanoaurate (I)
Diethyl cyanophosphonate	Octyl cyanide	Sodium sulfide
Fumaryl chloride	Potassium cyanide	Toluene diisocyanate
Heptyl cyanide	Sodium cyanide	

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 UW 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. Examples of oxidizers are shown in Table 2-4.

Table 2-4 Oxidizers

Ammonium dichromate	Lithium perchlorate	Potassium chlorate
Ammonium nitrate	Nitric acid	Potassium permanganate
Chlorine (liquid or gas)	Nitric oxide	Sodium nitrate
Chromic acid	Oxygen (liquid or gas)	Strontium nitrate
Guanidine nitrate	Perchloric acid	Sulfuric acid

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. Examples are shown in Table 2-5.

Table 2-5 Chemicals that May Polymerize

Acrylic acid	Isopropenyl acetate	Vinyl bromide
Acrylonitrile	Styrene	2-Vinylpyridine
1,3-Butadiene		

d. Pyrophoric Chemicals

A chemical that will ignite spontaneously in air at or below 130 °F (54 °C) is a 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 the opening paragraph of Section G above need to be documented in your SOPs. Examples are shown in Table 2-6.

Table 2-6 Pyrophoric Chemicals

Barium metal	Potassium metal	Sodium methylate
Lithium diisopropyl amide	Rubidium metal	Tert-butyllithium
Magnesium powder	Silane	Triethylphosphine
Methyl lithium	Sodium hydrosulfite	Tri-n-butylphosphine
Phosphorus sticks	Sodium methoxide	Trimethylaluminum

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 3 or 4 and the extra precautions taken as described in the opening paragraph of Section G above need to be documented in your SOPs. Examples of water-reactive chemicals are shown in Table 2-7.

Table 2-7 Water Reactive Chemicals

Alpha-toluenesulfonyl fluoride	Oxalyl chloride	Sodium metal
Antimony trichloride	Phosphorus oxychloride	Tert-butyllithium
Calcium hydride	Phosphorus pentachloride	Titanium (IV) chloride
Hydrobromic acid	Phosphorus pentasulfide	Trimethylchlorosilane
Lithium aluminum hydride	Potassium metal	

2. Potentially Explosive Chemicals

An explosive chemical, when subjected to heat, impact, friction, 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 are:

a. Nitrated Compounds

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

Purchase nitrated compounds in small quantities. Do not break the seal on the cap until the chemical is needed.

When you purchase a nitrated compound, weigh the container and note the weight on the bottle. 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, again 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 need to be addressed in your SOPs are described in the opening paragraph of Section G above. Examples of nitrated compounds are shown in Table 2-8.

Table 2-8 Nitrated Compounds

Diphenyl hydrazine	3-Nitrotoluene	Trinitrophenol (Picric acid)
Nitrocellulose	Trinitrobenzene	Trinitrotoluene

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. These metal picrates 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 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 the opening paragraph of Section G above and in this section) need to be documented in your SOPs. Below is a list of good laboratory practices. For more information, see the Peroxide Forming Chemicals Management and Assessment Guidelines online at <http://www.ehs.washington.edu/forms/epo/peroxideguidelines.pdf>.

- 1) Highly Concentrated Peroxides - Over a period of 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 in that 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 you see crystals on or around the container cap. Call for assistance if you are concerned about opening the container (EH&S, 206-616-5835).

- 3) Required Procedures - Purchase peroxide forming solvents in small quantities that contain an inhibitor, such as butylated hydroxytoluene (BHT), which will delay the formation of peroxides until the inhibitor is used up. Label the container with the date received and opened. Label the container with the standard peroxide label (UoW 1716) (see Figure 2-4 below). 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.

Figure 2-4 Peroxide Label (UoW 1716)

UoW 1716 (10/07)

CAUTION PEROXIDE FORMING CHEMICAL	
Date Received ___/___/___	INHIBITOR ADDED <input type="checkbox"/> Yes <input type="checkbox"/> No
Date Opened ___/___/___	Type _____
Date Expires ___/___/___	
Limited shelf life. Store tightly closed away from light and heat. See UW Peroxide Guidelines or call 206-616-0595 for more information.	
Test Date _____ Peroxide _____ Tester _____	
Test Date _____ Peroxide _____ Tester _____	

<http://www.ehs.washington.edu/forms/epo/peroxideguidelines.pdf>

- 4) Testing Peroxides - It is a good laboratory practice to use test strips to test the solvent for peroxides prior to each use. 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. Test and treatment methods can be obtained by calling EH&S at 206-616-5835. Extreme caution should be exercised if concentrations of peroxides exceed 30 ppm.
- 5) Distillation and Evaporation Precautions - Always test for peroxides before distillation or evaporation because these procedures will increase the concentration of any peroxides present. 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.
- 6) Use of Inhibitors – Inhibitors slow the formation of peroxides in the future. They do not reduce or remove peroxides. Organic peroxides should be reduced safely.
- 7) Monitoring Expiration Date - Use the solvent before the manufacturer's expiration date. Peroxide-forming solvents exceeding their expiration date cannot be discarded through EH&S until the contents have been tested for peroxides. Examples of peroxide formers are shown in Table 2-9 below.

Table 2-9 Peroxide-Forming Chemicals

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

c. Azides

Organic and inorganic azides, R-N₃, can explode when heated or exposed to ground glass joints. Some azides are shock sensitive. Metal azides are relatively insensitive to shock, but may explode when heated. Sink disposal of azides can be extremely hazardous because they can form metal azides that are shock sensitive, like iron azide. Azides present a hazard around ground glass joints because they can be shock sensitive. Document additional precautions such as those described in the opening paragraph of Section G above in your SOPs.

d. Fulminates

Fulminates are compounds that contain a carbon-nitrogen-oxygen group. Metal fulminates such as mercury, silver, gold are highly explosive. Explosions are typically initiated by heat. Silver fulminates can form in undiscarded Tollen's reagent. Document additional precautions such as those described in the opening paragraph of Section G above in your SOPs.

3. Highly Toxic Substances

a. Precautions for Use

In laboratories, "Particularly Hazardous Substances" (described and partially listed in Appendix H, at <http://www.ehs.washington.edu/manuals/lsm/lsmh.shtm>) includes those chemicals that are highly toxic. The procedures for using such chemicals require additional precautions, as described above in the opening paragraph in Section G.

b. Categories of Highly Toxic Chemicals

Various regulatory agencies define highly toxic chemicals differently. Appendix H of this manual provides the UW criteria for “Highly Toxic” chemicals.

The International Fire Code 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 Centers for Disease Control and Prevention recognizes highly toxic “select agents and toxins.” Information and the regulation pertaining to select agents and toxins are available at <http://www.cdc.gov/od/sap/index.htm>. Select agents and toxins are allowed in only specific spaces on campus and 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.

4. Carcinogens and Reproductive Hazards

Additional care must be taken to minimize exposures to known and suspected carcinogens and reproductive hazard chemicals because inadequate information is available in many cases as to what level of exposure may impact the worker. A partial list of such chemicals is given in Appendix H of this Laboratory Safety Manual, Particularly Hazardous Substances. Ways to minimize exposures include steps such as substituting chemicals if possible, using the smallest amounts necessary, and using a fume hood or other control system. Additional information is available on the EH&S Reproductive Hazards web page at <http://www.ehs.washington.edu/ohsreprohaz/reprohazguidance.pdf>.

5. Hazardous Drugs

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 cancer 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 hazardous drugs. These include use of exhausted enclosures, procedures to avoid personal exposure and contaminating surfaces, personal protective equipment (PPE), and training of personnel in hazard awareness and safe work practices. For more information, see Chemotherapy and Other Hazardous Drugs, Safe Use Guidelines.

6. Sensitizing or Allergenic Chemicals

Potent chemicals which can cause sensitization or allergy may impact researchers by changing their style of life and in some cases forcing them to leave their areas of research. This hazard is not limited to “traditional” laboratory chemicals in that researchers handling animals can become allergic to animal danders and researchers in forest resources can develop allergies to molds, to give two examples. Additional examples are shown in Table 2-10.

Table 2-10 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 may range from a contact dermatitis to anaphylactic shock.

Care must be taken to minimize exposures. Situations which may lead to a high, acute exposure, such as cleaning up a spill, should be carefully assessed to keep the exposure as low as reasonable. If a person is sensitized or allergic to a similar chemical, any control which will prevent exposure to the lab chemical should be implemented, whether improved ventilation, barriers, or improved procedures. If respirators are to be used, the person must comply with all steps in the UW Respiratory Protection Program (<http://www.ehs.washington.edu/ohsresp/index.shtml>).

7. Synthesized Chemicals

Synthesized chemicals may present unexpected hazards. The first step should always be to perform a literature review concerning the expected hazards from the proposed procedures and the hazards from chemicals with similar structure, taking into account that these hazards are being assumed. Pay particular concern to hazards which may develop 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” is given to particles with at least one dimension less than 100 nanometers. They may be deliberately engineered or develop naturally. Such particles may be more reactive and toxic than bulk size chemicals. Take special care to prevent them from being released into the environment. If your laboratory intends to create nanoparticles in such a manner that they may be aerosolized, measurements of the typical nanoparticle levels before the process begins may be taken and compared to subsequent levels. Additional information about nanoparticle safety guidelines is available at <https://www.ehs.washington.edu/psoinfofor/nanosafeguide.pdf> or by contacting the UW Chemical Hygiene Officer (uwcho@uw.edu).

b. Providing Synthesized Chemicals to Others

A laboratory synthesizing chemicals for use by others should consider themselves to be a resource for others receiving the chemical who may need hazard information. Staff

synthesizing a hazardous chemical should provide those others with as much information about the safety precautions when using the chemical as is feasible.

If you produce a chemical substance for use by another agency outside the University of Washington 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 WAC 296-839, SDS and Label Preparation. For more information, please contact the UW Chemical Hygiene Officer at uwcho@uw.edu.

8. Compressed Gases, Gas Cylinders and Liquid Cryogen Containers

Compressed gas is a generic term used for 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 they are pressurized in a gas cylinder. Refrigerated liquefied gases are also known as cryogenics become liquid at very low temperatures. The cryogenic gases have boiling points below -150°C . Dissolved gases are gases which are dissolved in other substances while stored in gas cylinders. Additional details are available on the EH&S Compressed Gases website, at <https://www.ehs.washington.edu/fsohazmat/gascylinders.shtm>.

a. Hazards of Compressed Gases

- 1) Both physical and health hazards are present with 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 dangers of low temperature, potential frostbite, and they 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 for toxic materials may be very low and 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 listed on the gases' Safety Data Sheets (SDSs).

b. Safe Practices

The following safe practices should be followed 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 that 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 can not be seen from the application point.
- 5) Use, store, and transport cylinders in an upright position unless they qualify to be stored horizontally. (See Storage section on Compressed Gas web page for more information)
- 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 (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 so that they cannot be knocked over. See paragraph 2.G.8.c below for additional transport requirements.
- 8) Make sure caps are in place when 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, depressurize the system, and then turn off the regulator. If the cylinder will not be used for a while, 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 to be "in use" and not subject to incompatibility storage requirements. (See Compatibility section on Compressed Gas web page for more information)
- 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 flammable gases next to an exit or near oxygen cylinders.
- 17) Do NOT use or permit contact of solvents, oil, or grease on cylinders or their valves.
- 18) 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.

- 19) 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, they must:

- 1) Have the metal outlet cap/plug installed,
- 2) Have the valve cap installed if the cylinder has one, and
- 3) Be secured 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 provided, passenger elevators may be used. Passengers (other than the material handler) are not allowed in elevator cabs with compressed gas and cryogen transport.

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 be served by permanent gas piping systems and temporary gas piping systems should be as short as possible and may only be in one room. Find more specific information on the Compressed Gas web page.

f. Regulators

Pressure regulators are used to lower gas pressure to a useable level. There are two different types of regulators and specific precautions must be taken when using them. The Compressed Gas web page provides additional information.

g. Compressed Gas Shipments

Whenever possible, researchers should purchase compressed gas through the preferred supplier, Praxair. See Section 2.C.7 above for ordering information. When it arrives, inspect the cylinder to make sure it is the gas 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 the section concerning procurement of gas cylinders (Section 2.C.7). Additional information about cylinder disposal is described in Section 3.P of this Laboratory Safety Manual. If returning full or partially full cylinders, shipping precautions as described on the Compressed Gas web page need to be followed.

9. Flammable and Combustible Liquids

Read the full SDS for more details before handling flammable and combustible liquids.

Know the flash points of the flammable or combustible materials that 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 of the 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 those 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 4 for “Flammability” are also considered particularly hazardous substances and need additional precautions as described in the opening paragraph of Section G above. Also, pre-plan for an emergency by adhering to the precautions in Section 9.A.2.c such as wearing lab coats which resist burning, preventing clutter, 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

Use less hazardous chemicals if 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 not performing your procedure but flammable chemicals are still present.

Each flammable liquid has two fairly definite limits defining the range of concentrations in mixtures with air that will propagate flames or explode. The limits are called the Lower Flammability Limit (LFL) and the Upper Flammability Limit (UFL). 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. The flash points and the ranges of LFL to UFL are shown for some typical laboratory chemicals in the following table (Table 2-11. Flash Points and Flammability Limits of Some Chemicals).

Table 2-11 Flash Points and Flammability Limits of Some 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 appropriately designed for flammable liquids (no internal ignition sources and/or 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 because along with being a potential ignition source, it is also harder to maintain exact control of the heat applied.

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 you will need.

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 and can travel considerable distances along a benchtop or the floor and can potentially be ignited by an ignition source located somewhere else 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 and polyethylene containers larger than 5 (five) gallons (20 liters) must be grounded to avoid static charge when transferring flammable liquids to another container.

Grounding can be direct, as a wire attached to both containers, or indirect, as through 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 graduate cylinder or beaker, proceed slowly to give any static charge time to disperse. Or, conduct the procedure in an inert atmosphere.

10. Homeland Security Chemicals of Interest

Regulations at Title 6 Code of Federal Regulations Part 27 require all chemical facilities (including universities) comply with the Chemical Facility Anti-Terrorism Standards (CFATS). The rule requires that a chemical facility that either possesses or later comes into possession of listed chemicals (http://www.dhs.gov/xlibrary/assets/chemsec_appendix-chemicalofinterestlist.pdf) in quantities that meet or exceed threshold quantities report them to the Department of Homeland Security (DHS). Under this regulation, a University building is deemed a chemical facility and EH&S is charged with reporting building exceedances to DHS. EH&S relies on the accuracy of your chemical inventories maintained in the MyChem database to determine what is reportable.

DHS can require a facility to prepare a security vulnerability assessment and implement a site security plan. Failure to comply with these requirements can result in fines and/or imprisonment.

DHS regulates certain chemicals in the rule in any amount if transported (shipped) away from campus. See Table 2-13 below for a list of 22 chemicals regulated in any amount if shipped. Do not ship these chemicals without notifying EH&S in advance. EH&S is responsible for reporting all UW shipments of these chemicals to DHS.

EH&S has developed a “do not ship” warning label which reminds workers that the substance is federally regulated and cannot be shipped without prior EH&S notification. (Refer to section G.9.b below.)

a. Do Not Ship List

DHS identifies 22 chemicals that are reportable in any amount when transported (shipped) away from campus. The following table, Table 2-12 Reportable if Shipped Chemical List, provides a list of these chemicals by name and CAS number.

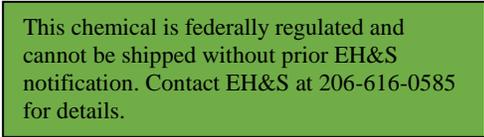
Table 2-12 Reportable if Shipped Chemical List

Acetone cyanohydrin, stabilized (75-86-5)	Magnesium phosphide (12057-74-8)
Aluminum phosphide (20859-73-8)	Methyldichlorosilane (75-54-7)
Boron tribromide (10294-33-4)	Phosphorus oxychloride (10025-87-3)
Bromine pentafluoride (7789-30-2)	Phosphorus pentasulfide (1314-80-3)
Bromine trifluoride (7787-71-5)	Phosphorus trichloride (7719-12-2)
Calcium phosphide (1305-99-3)	Potassium phosphide (20770-41-6)
Chlorine dioxide (10049-04-4)	Sodium phosphide (12058-85-4)
Chloroacetyl chloride (79-04-9)	Strontium phosphide (12504-16-4)
Chlorosulfonic acid (7790-94-5)	Sulfuryl chloride (7791-25-5)

Lithium amide (7782-89-0) Lithium nitride (26134-62-3)	Titanium tetrachloride (7550-45-0) Trichlorosilane (10025-78-2)
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b. Do Not Ship Labels

If you possess any of the 22 listed chemicals in a purchased formulation, attach a warning label to the original container to remind workers that the substance is regulated and cannot be shipped away from campus without prior EH&S notification. Notify EH&S before shipments by calling 206-616-0585. See Figure 2-5 Do Not Ship Label for a sample label. Laboratories can print their own labels or obtain printed labels from EH&S by calling 206-616-0585.

Figure 2-5 Do Not Ship Label

This chemical is federally regulated and cannot be shipped without prior EH&S notification. Contact EH&S at 206-616-0585 for details.

c. Disposing of Chemicals on the Do Not Ship List

If you wish to dispose of any of these “do not ship” chemicals, you must submit a chemical waste collection request (<http://www.ehs.washington.edu/forms/epo/1470.pdf>) to EH&S as described in Section 3 of this manual.

Acetone cyanohydrins (stabilized), aluminum phosphide, and phosphorus pentasulfide must be treated before collection. Contact EH&S for details before filling out the collection request if you wish to dispose of one of these three chemicals.

11. 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. The basic regulation is viewable at <http://www.lni.wa.gov/safety/rules/chapter/67/> and a table listing chemical limits in pounds that require implementation of this process is in Appendix A to that regulation, at WAC 296-67-285.

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

- What-If,
- Checklist,
- Fault Tree Analysis,
- Hazard and Operability Study (HAZOP),
- Failure Mode and Effects Analysis (FMEA), or
- 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 in earlier paragraphs in this section.



Section 3 - Chemical Waste Management

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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. 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 and 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. See <http://www.ehs.washington.edu/psotrain/corsdesc.shtm> for more information.

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.

In order to determine whether or not your chemical is hazardous, use your knowledge, the chemical’s original label and/or the chemical’s Safety Data Sheet/Material Safety Data Sheet (SDS/MSDS) to determine if the waste is corrosive, flammable, toxic, reactive, “persistent in the environment” and/or mutagenic or carcinogenic, as defined in the below subsections.

1. Flammable/Ignitable

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

- A liquid having a flash point less than 140 °F (e.g., ethanol, xylene, 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/MSDS 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 and 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 (note that a chemical is not allowed to be poured down the drain if it has a pH of less than 5.5 or greater than 12 – see subsection B.8 below.)

3. Reactive

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

- 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 LC₅₀ (*concentration* of substance required to kill 50% of the tested population) for fish or the LD₅₀ (*dose amount* of substance required to kill 50% of the tested population) for rats. This information is usually listed on a chemical's SDS/MSDS.

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 (see 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, online at <http://www.ehs.washington.edu/forms/epo/1957.pdf>. EH&S staff will then evaluate your waste and advise you on proper disposal of your chemical.

b. EPA P-listed Hazardous Waste

EPA “P-listed” chemicals have especially acute toxicity hazards, and because of this, more stringent requirements when disposed as hazardous waste. Refer to Washington Administrative Code 173-303 for specific information, such as the P-listed chemicals, at <http://app.leg.wa.gov/WAC/default.aspx?cite=173-303-9903>. Contact EH&S at 206-616-5835 for current information.

A waste is regulated under the 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 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 the 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.

For the Federal listing of EPA P-listed chemicals, see

<http://www.gpo.gov/fdsys/pkg/CFR-2012-title40-vol27/xml/CFR-2012-title40-vol27-sec261-33.xml> .

5. Persistent

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

a. 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:

$$\text{Total HOC Concentration} = 0.009\% + 0.012\% + 0.020\% = 0.041\%$$

b. Polycyclic Aromatic Hydrocarbons

The following polycyclic aromatic hydrocarbons (PAHs) are regulated: acenaphthylene, acenaphthene, 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, fluorene, 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:

$$\text{Total PAH Concentration} = 0.08\% + 1.22\% = 1.30\%$$

6. 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. EH&S nevertheless 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, <https://www.ehs.washington.edu/rbsresplan/chemohazdrug.shtm> .

7. Trash Rules

Non-hazardous solid chemicals can go in the trash. Known, probable or suspected carcinogens, irritants and sensitizers cannot go in the trash.

Deface labels. Bag and label 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. Also, empty containers for extremely toxic chemicals are hazardous waste unless you triple rinse them and dispose of the rinseate as hazardous waste.

8. Local Sewer Limits

These rules determine what can be poured down the sink and sometimes supersede Hazardous Waste rules. Please also refer to the local sewer limits rules in Section F below.

9. Waste Evaluation Request

If you are unsure whether your waste is hazardous, please submit an online [Waste Evaluation Request](#). Fill out all information completely, and attach the SDS/MSDS(s) for the chemical(s) to it. EH&S staff will evaluate your waste stream for you and advise you on proper disposal.

C. HAZARDOUS WASTE ACCUMULATION RULES

Follow the below rules for hazardous chemical waste accumulation.

1. Appropriate Containers

Accumulate waste in an appropriate container compatible with the waste. You may reuse containers, even containers that were used for other chemicals, if they have been rinsed and the original labels have been defaced (note that the rinseate may be hazardous waste according to the definitions in Section B, above.) Containers that were designed for solid chemicals should not be used for liquids. 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.

Finally, do not fill the containers completely. Each container must have at least a one inch of headspace above the waste when it is collected. 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, Figure 3-1, on the following page.

Figure 3-1 Hazardous Waste Label

The form is titled "HAZARDOUS WASTE" and is from the "UNIVERSITY OF WASHINGTON ENVIRONMENTAL HEALTH AND SAFETY (206) 685-5811". It contains a table for "CHEMICAL COMPOSITION AND ASSOCIATED HAZARDS" with columns for chemical name and percentage. Below this is a section for "WASTE GENERATOR INFORMATION" with fields for Department, Building, Room, and Floor. There are also checkboxes for hazard types: Corrosive, Non-Hazardous, Irritant, Toxic, Flammable, Solid, and Other (explain).

Fill out the 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 MSDS 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.

Booklets of twenty adhesive hazardous waste labels are available free at the following locations:

Biochemistry Stores

Location: J-014 Health Sciences Building
Hours: Monday – Friday 8:15-12:00, 1:00-4:45
Last day of the month 8:15-12:00, 1:00-3:30

Chemistry Department Research Stockroom (Chemstore)

Location: 036 Bagley Hall
Hours: Monday – Friday 8:30-12:00, 1:00-4:30
Closed on UW employee holidays

Or, email chmwaste@u.washington.edu to request that labels be mailed to you. Hazardous waste labels may also be printed out online at <http://www.ehs.washington.edu/epowaste/hazwastelabel.shtm> .

3. Location

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 liquid storage cabinets for flammable waste over ten gallons in volume.

Store the waste away from emergency equipment such as safety showers and emergency access panels. Do not block exits.

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

4. 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.

5. Accumulation Volume 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. See <http://www.ehs.washington.edu/epowaste/ehw.shtm> for how to determine whether your waste is extremely hazardous waste.

Also, any one type of flammable chemical (including waste) cannot exceed the limits specified by the controlling 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 sprinklered building and 30 gallons in a nonsprinklered building. Contact EH&S at 206-543-0465 with questions about control areas and volume limits if you accumulate large amounts of flammable hazardous waste, or arrange for more frequent collection of this waste.

Leave some headspace (at least one inch) in each container to allow for pressure changes due to changes in temperature.

Chemical waste must not be accumulated (*i.e.* stored) for more than one year.

6. Large Containers (Drums)

If you are accumulating wastes in containers greater than five gallons in volume, make sure that drums used to accumulate regulated wastes are in good condition and are approved by Department of Transportation (DOT) for highway mode transportation. If the drums were shipped to you in the first place, they are very 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.

7. 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 you do your annual chemical inventory update.

Please also see the section on “legacy chemicals” in Section G.3, below. Legacy chemicals are those that are left behind by laboratory staff when they leave the university or move laboratories. They become the responsibility of the new space occupants.

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. There are about 3500 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 by submitting a Chemical Waste Collection Request found online at <http://www.ehs.washington.edu/forms/epo/1470.pdf>. Fill out all information completely and fax or mail the form (information is on the form).

3. Routine Collection Requests

Wastes that are 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, you then simply 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 at <http://www.ehs.washington.edu/forms/epo/routinepickup.php>.

To set up a new routine, fill out and send a New Routine Chemical Waste Collection Request at <http://www.ehs.washington.edu/forms/epo/1471.pdf>. If you have any questions about whether your waste is routine, email chmwaste@u.washington.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. Call at least a month before your deadline.

For fewer than 100 containers, fill out and send the copies of the Chemical Waste Collection Request (<http://www.ehs.washington.edu/forms/epo/1470.pdf>) to EH&S, making sure to put your name on each of the pages. Place completed UW Hazardous Waste Labels on each waste container (not needed for containers with an original label and original contents).

Consider the MyChem Chemical Exchange for your unwanted but useable chemicals. "Useable" chemicals are unexpired and preferably unopened.

Finally, 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 University of Washington. 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, see the Waste Minimization subsection below or visit <http://www.ehs.washington.edu/epohazreduce/index.shtm>.

All hazardous waste at the University of Washington 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 high temperature. A few waste streams are placed in permitted hazardous waste landfills.

E. TRASH DISPOSAL

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 (see a current MSDS/SDS for the chemical to determine if the 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, 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, no-nonsense means, such as inverting and draining, shaking, scraping, or scooping", and
- No more than 3% 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. The definition for extremely hazardous wastes is on the EH&S website at <http://www.ehs.washington.edu/epowaste/ehw.shtm>. Also, if your chemical is a known or suspected carcinogen, such as those listed in Appendix H of this manual, 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:

- 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.
- With a pen or marker, cross out or black out the labels on the container.
- Leave the container uncapped. Throw the cap away separately.
- If the container fits in the trashcan, place it there. If it does not fit in the trashcan, place it next to the trash.
- 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 do 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 also help others in your workplace know that the container contains hazardous waste, not the original chemical.

Do not recycle glass or plastic containers that contained chemicals unless approved by EH&S. Recycled glass and plastic is used for beverage and food containers, so the recycling industry does not accept chemical containers. However, EH&S does recycle large plastic and metal drums; see <http://www.ehs.washington.edu/eporecycle/drums.shtm> for more details.

See also the empty container recycling guidelines on the EH&S website at <http://www.ehs.washington.edu/epowaste/trashcontainer.shtm>.

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.

Finally, 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 contaminated items as hazardous waste.

F. SEWER DISPOSAL

All wastes discharged to the sanitary sewer system must be under the local Sewer Discharge Limits designed to protect surface waters and maintain the quality of biosolids from wastewater treatment plants.

1. King County Local Sewer Discharge Limits

In King County, you may dispose of some chemicals down the sanitary sewer drain in some circumstances. This method of disposal is also known as "sewering". Records of this disposal must be kept as described in Section F.3 below. If your waste qualifies as hazardous waste (according to the criteria in Section B above) then you may not sewer the waste.

King County has published local discharge limits for commonly used chemicals. These limits are on the EH&S website at <http://www.ehs.washington.edu/epowaste/sink.shtm>. They apply only to UW Seattle, UW Bothell, and other sites within King County,

2. Outside King County

If you are outside King County (Tacoma, Pack Forest, and Friday Harbor), local sewer limits have not been formally adopted in these areas. Operators of some very small waste treatment plants allow chemical disposal to sanitary sewer only on a case-by-case basis in order 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 following web page for example treatment methods: <http://www.ehs.washington.edu/epohazreduce/index.shtm>.

You must keep a log of all hazardous wastes that you have treated, and provide it to EH&S upon request. An example chemical treatment log can be found on the EH&S website: <http://www.ehs.washington.edu/forms/epo/chemlog.pdf>.

4. Soaps, Bleach and Acetone

When you are washing glassware or equipment, you will likely use chemicals such as detergents and bleach. Standard household bleach and other cleansers may go down the drain.

Acetone may not go down the sink 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 (see 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. They are listed at http://www.ehs.washington.edu/rsowaste/rad_scint_sewer.shtm. 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 wastes such as equipment rinse water or any chemical treatment that you do as a normal part of cleaning up after an experiment, as long as it meets sewer disposal 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 the chemical. If that fails, complete and mail or fax to EH&S a Chemical Waste Collection Request, online at <http://www.ehs.washington.edu/forms/epo/1470.pdf>. 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.

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

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 such as p-dioxane, diethyl ether, tetrahydrofuran and acetaldehyde that have exceeded the manufacturer's expiration date will not be collected for disposal until they have been tested for peroxides. These chemicals must be managed correctly. For more information, see section 2.G.2.b earlier in this manual and the *EH&S Peroxide Forming Chemicals Management and Assessment Guidelines* online at <http://www.ehs.washington.edu/forms/epo/peroxideguidelines.pdf>.

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; email chmwaste@uw.edu to obtain more information about them.

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 3 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. 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

Principal investigators are required to completely clean out laboratories before they leave, including all hazardous chemicals and waste (see Section 10, Moving In/Moving Out.) However, sometimes people leave without disposing of chemicals properly.

Legacy chemicals are unwanted chemicals that are sometimes left behind after a move. If you move into a laboratory that has legacy chemicals in it, you should tell your department administrator immediately. If your department cannot, for whatever reason, 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 five 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.

More information is at <http://www.ehs.washington.edu/epohazreduce/index.shtm>. There you will find an extensive and detailed list of services and resources.

1. Chemical Procurement and Chemical Exchange

Purchase only what you'll use, especially if you're purchasing a hazardous chemical. One recent study suggested that up to 40% of the hazardous waste produced by laboratories is actually unused and expired chemicals.

Shop for free chemicals in the MyChem Chemical Exchange. For more information, see the EH&S website at <http://www.ehs.washington.edu/eporecycle/chemex.shtm>.

2. 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. Please see <http://www.ehs.washington.edu/epohazreduce/index.shtm> for more details.

3. Hazardous Materials Recycling

Both EH&S and UW Recycling manage the recycling of materials that would otherwise be disposed of as hazardous waste. See <http://www.ehs.washington.edu/eporecycle/index.shtm> for all the common (and sometimes uncommon) items recycled at the UW, from batteries to computer monitors to elemental mercury to scrap metal.

I. SOLID WASTE AND RECYCLING

Below are guidelines for recycling a number of 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 for them. Storing boxes in aisles or 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, see UW Recycling's procedures webpage at <http://www.washington.edu/facilities/transportation/recyclingandsolidwaste/>.

2. Plastic and Glass

Plastic and glass chemical containers are not recyclable at this time. 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. UW Recycling and the EH&S Environmental Programs Office are currently pursuing limited recycling for some laboratory plastics.

3. Packaging Materials

UW Recycling also coordinates the recycling of wooden pallets, packaging "peanuts", plastic wrap and other packaging materials. Styrofoam packaging is handled on a case-by-case basis. For more information on all these items, see <http://www.washington.edu/facilities/transportation/recyclingandsolidwaste/procedures> .

4. Printer Cartridges

Most types of printer cartridges and components can be recycled. For more information, see <http://www.washington.edu/facilities/building/recyclingandsolidwaste/procedures/cartridges> .

5. Batteries

Battery collection is a joint effort by UW Recycling and EH&S Environmental Programs. Small amounts of batteries can be recycled through the e.Media system (<http://www.washington.edu/facilities/building/recyclingandsolidwaste/procedures/emediasystem>). Large, heavy, and/or unusual research or clinical batteries, as well as large volumes of batteries, are handled two ways.

a. One-Time Battery Collection

To request a large one-time collection of batteries, fill out and send a Battery Collection Request at <http://www.ehs.washington.edu/forms/epo/1943.pdf>.

b. Routine Battery Collection

If you have a routine number, request a pickup with the online Routine Collection Request at <http://www.ehs.washington.edu/forms/epo/routinepickup.php>.

J. “SHARPS” AND “LAB GLASS”

The following are guidelines for the disposal of “sharps” and “lab glass.”

1. “Sharps”

Sharps are a regulated waste classification. The "sharps" definition specifically includes:

- All syringes
- All hypodermic needles
- IV tubing with attached needles
- Lancets
- Scalpel blades

“Sharps” also includes the following if contaminated with a biohazardous material (including recombinant or synthetic DNA/RNA):

- Broken glass
- Razor blades
- Pasteur pipettes
- Pipette tips
- Glass tubes
- Glass slides and cover slips
- Other, similar items

“Sharps” must be disposed in a red plastic sharps container which is leak proof, rigid, and puncture-resistant. It must be labeled with a biohazard symbol, and be equipped with a tight-fitting lid for use during handling and transport. Various sizes of sharps containers are available from Biochemistry Stores and vendors.

Close and prepare for decontamination and disposal a sharps container when 2/3 full. 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. Refer to the EH&S web page <http://www.ehs.washington.edu/rbsresplan/sharp.shtm> for specific disposal instructions.

All sharps containers must be decontaminated prior to disposal. The method for getting sharps waste collected and treated 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 Chart for your specific location via the web page <http://www.ehs.washington.edu/rbsresplan/sharp.shtm> .

2. Bio-Hazardous Glass Items

Biohazardous lab glass and plastic must be decontaminated prior to disposal. Contaminated pipettes can be placed in a pipette box/keeper, while other biohazardous-contaminated glass or plastic items can go into a heavy cardboard box lined with a biohazard bag. The box must be labeled with the biohazard symbol. An EH&S poster showing examples of these boxes is at http://www.ehs.washington.edu/rbsresplan/poster_sharps_labglass.pdf .

3. “Lab Glass”

“Lab glass” waste (including plastic items) is defined as items that could puncture regular waste bags and endanger waste handlers, and is not contaminated with a biohazardous material. This category never includes syringes, lancets, scalpel blades, or hypodermic needles.

Examples of “lab glass” include:

- Broken glassware
- Empty chemical containers such as test tubes, pipettes and pipette tips, and centrifuge tubes
- 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 and clearly identify the PI name and room number. 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.

The sealed box is placed 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 waste disposal requirements, see Section 4.F of the UW Biohazard Safety Manual, at http://www.ehs.washington.edu/rbsbiosafe/BSM_Sec4.pdf . For general information about infectious waste, see <http://www.ehs.washington.edu/ohsreslab/biowaste.shtm>.

L. RADIOACTIVE WASTE

For radioactive waste, see the UW Radiation Safety Manual, Section 14 (Radioactive Waste) at <http://www.ehs.washington.edu/manuals/rsmanual/14waste.pdf>.

M. MIXED WASTE

Most mixed wastes consist of low level radioactive wastes combined with hazardous materials.

University of Washington 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 University of Washington 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 University of Washington by federal and state agencies if mixed wastes were generated and/or stored on campus.

Exceptions to the production of mixed waste includes liquid scintillation cocktails 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 Liquid Scintillation Cocktail (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. They are listed at http://www.ehs.washington.edu/rsowaste/rad_scint_sewer.shtm.

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, 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

Contact Property and Transportation Services at 206-685-1565 to arrange for disposal of non-contaminated animals and animal by-products. Contact the Facility Manager with the UW Department of Comparative Medicine at 206-543-0641 to make arrangements to deliver the whole animal to them for disposal.

P. GAS CYLINDERS

Gas cylinders used on campus must be either rented or, if purchased, purchased from the preferred supplier, 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 gas cylinder web page (<http://www.ehs.washington.edu/fsohazmat/gascylinders.shtm>).

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, paid by the laboratory.

Empty lecture bottles may be discarded as scrap metal after the main valve is unscrewed and detached and the bottle has been flushed with an inert gas or rinsed with an appropriate solvent.

Cylinders containing constituents which are normally part of air should be vented to the atmosphere until they are empty. Empty cylinders may be discarded as scrap metal after the main valve is unscrewed and detached and the cylinder has been flushed with an inert gas or rinsed with an appropriate solvent. Calibration gas cylinders containing hazardous constituents in the 1 to 100 ppm range may be eligible for venting.

For more information, see <http://www.ehs.washington.edu/manuals/fswaste.pdf>. For assistance about the disposal of gas cylinders, complete and submit a Waste Evaluation Request at <http://www.ehs.washington.edu/forms/epo/1957.pdf> or email chmwaste@uw.edu.



Section 4 - Laboratory Equipment and Facilities

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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 (unobstructed) and personnel should be able to reach the equipment within 10 seconds (not more than 50 feet and perhaps closer if access is through a normally closed door). Equipment must be accessible at all times without requiring a key or overcoming other security safeguards.

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 at all possible, don't work alone when working with these chemicals.

Eyewashes must be flushed weekly by laboratory staff to ensure they are operating correctly in accordance with Washington Administrative Code (WAC) 296-800-15035, to check that they work and provide a strong enough stream of water to reach the eyes of someone bending over it, and to help keep the water clean. During the weekly check, the eyewash should be operated long enough, perhaps 30 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.

2. Safety Showers

Laboratory personnel should know the location and use of the emergency showers in their area. Laboratory personnel must 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. Deluge Hoses

Deluge hoses have been replaced with dual eyewash stations. Deluge hoses are not acceptable alternatives to an eyewash or safety shower. They can be used for washing glassware and other materials. If your lab has a drench hose without an eyewash but an eyewash is needed, submit a work request to have an eyewash installed. Contact EH&S at 206-543-7388 if you have questions.

B. FIRE SAFETY EQUIPMENT

1. Fire Extinguishers

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, with online registration at <http://www.ehs.washington.edu/psotrain/index.shtm>. 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 incipient (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.

Fire extinguishers should be conspicuously located, wall mounted, and easily accessible.

b. Types of Extinguishers

The fire extinguishers available to the laboratory staff should be selected based on the materials inside or outside the lab. See Table 9-4 for the list of fire classes.

Table 9-4 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 CO₂ extinguisher (Class BC). It is not as effective as a dry chemical extinguisher, but will require less clean up after use. Some pressurized water fire extinguishers (Class A) are still found in hallways but they are only suitable for use on ordinary combustible materials (e.g., paper, wood, plastic).

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 at 206-685-1484. To request additional or alternative extinguishers, contact EH&S at 206-543-0465. For repair or replacement of fire extinguishers at Bothell or Tacoma campuses, please refer to Appendix F.

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 Liquid Storage Cabinets

Flammable liquid storage cabinets are required if you are storing over ten gallons of flammable liquids. Flammable liquid storage cabinets are **not** fireproof. Cabinets are designed to protect the contents from extreme temperatures for a limited time only. Contact EH&S at 206-543-0465 for further information on flammable liquid storage cabinets.

a. UL or FM Approval

Flammable liquids should be stored in an Underwriter's Laboratory (UL) listed or Factory Mutual (FM) approved flammable liquid storage cabinet outfitted with approved automatic or self-closing doors. All new cabinets must have UL or FM approval. (Note: Some existing wooden cabinets that are not labeled with UL or FM approval are still in service and approved for use.)

b. Label

Cabinets must be labeled "Flammable - Keep Fire Away"

c. Capacity

Do not over fill cabinets. Check manufacturer's recommendations for storage limits.

d. Bottles

All bottles should be placed on the shelves, never stacked. Keep all containers tightly closed.

e. Containers

Only containers designed for flammables 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.

g. Cabinet Doors

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

h. Unapproved Storage

Tops of cabinets are not storage shelves. Do not store combustible materials on or beside flammable liquid storage cabinets

3. Flammable Storage Refrigerators

Flammable chemicals or chemical mixtures that need to be stored below room temperature must be stored in U.L. listed flammable material storage refrigerators or freezers. These refrigerators and freezers are specifically designed by the manufacturer to have non-sparking interiors. 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 206-543-0465. For more information on flammable storage refrigerators, see <http://www.ehs.washington.edu/fsofire/flamfrig.shtm>.

C. LABORATORY SIGNS

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

Table 4-1 Safety-Related Signs

Safety-Related Required Signs	See 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” (Must be posted if valve is present.)	5.C.6
“Laboratory water – do not drink” (Must be posted on non-potable water outlets.)	4.C.7

1. Lab Caution Sign

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

Lab caution signs are installed by EH&S and updated by lab personnel using a tool in MyChem. Once the signs are posted by EH&S it is the responsibility of the lab personal (PI,

Lab Manager, 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. An example of the sign is shown in Figure 4-1 below and more information on the contents of the signs is available on the web page <http://www.ehs.washington.edu/fsohazmat/labsign.shtm>.

Figure 4-1 Example Laboratory Caution Sign



2. Emergency Procedures for Laboratories (Flip Chart)

Laboratories should have the UW Emergency Procedures for Laboratories flip chart posted in the lab in a prominent location. It contains detailed emergency procedures and phone numbers for eight different emergency situations. There is space on the front cover to write in emergency contact numbers for the lab. Provide numbers for lab personnel to be called in case of fire, accident, hazardous chemical spill or other emergency.

3. Laboratory Floor Plan

A plan showing evacuation route(s), as well as spill kit, fire extinguisher, and other safety equipment locations should be included in the Chemical Hygiene Plan and may be posted prominently in the laboratory. See Appendix C for an example of a laboratory floor plan.

If particularly hazardous substances are used in a designated area, the floor plan showing the designated area is mandatory.

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 to post these signs.

5. **Hazards Warning Signs**

Warning signs and labels should be posted in areas or on equipment where special or unusual hazards exist, such as biohazards, lasers, magnetic fields, 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 and possibly on local codes. Contact EH&S for information on these 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 Department of Labor and Industries 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 (See 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 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 on the EH&S web site at <http://www.ehs.washington.edu/fsfumehoods/approvedfumehoods.shtm>.

a. Fume Hood Use

- 1) Training – Personnel using fume hoods should take the on-line training class (at <http://www.ehs.washington.edu/fsfumehoods/index.shtm>).
- 2) 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 at the same time that EH&S measures the air velocity.
- 3) 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.
- 4) 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. 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.
- 5) 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.
- 6) 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.
- 7) Storage – Do not store chemicals or supplies in the fume hood. Chemicals and supplies should be stored in approved cabinets.
- 8) 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 flammable liquids and heat sources.
- 9) Containers – All containers of chemicals must be securely capped when not in use. A rule of thumb 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 cap them. 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 the material must be under continuous control of the researcher using it).

b. Fume Hood Prep for Maintenance

- 1) 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 G.2 Decontamination of Equipment for Service.
- 2) Maintenance may require access to the storage cabinets below the hood or to the sides of the hood. If this access is required, the entire cabinet and adjacent area also needs to be emptied, decontaminated, cleaned, and rinsed. Lab staff need to identify a contact for coordinating with Facilities Services regarding the work to be done.
- 3) See Section G.2 below for details and the required form.

c. Fume Hood Performance and Testing

EH&S performs a functional performance test roughly annually to assure hoods are performing as designed. If a hood 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 criterion, depending upon the fume hood design. This includes face velocity, variable air volume (VAV) tracking, sound, containment and monitor functionality. Specific performance measures for each test are outlined below. For more information contact EH&S at 206-543-0465.

- 1) 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.
- 2) VAV Tracking - The sash is lowered about 50% from the target sash height to assure the HVAC system responds appropriately to maintain optimal capture velocity.
- 3) 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.
- 4) Containment Test - Using visual powder or dry ice, check for effective containment.
- 5) Monitor Alarm Properly Functioning:
 - Confirm that the monitor has power and that it is properly calibrated. Raise the sash to reduce the face velocity below 80 LFM (60 LFM for low flow hoods) and to confirm that both the visible and audible alarm signals function.
 - Test the monitor’s mute function by pressing the mute button. Test the reset button.
 - This test fails if the monitor fails to alarm, is more than 10 FPM out of calibration, or if it fails any functional test or is damaged.

d. Fume Hood Problems

If you are having problems with your fume hood, contact EH&S at 206-543-0465. EH&S will troubleshoot the problem and may refer it to Facilities Services 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 206-543-0465.

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. The 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 the Institutional Biosafety Officer.

BSCs may not be repaired or moved until decontaminated by EH&S.

Refer to the EH&S Focus Sheet "Chemical Use in Biological Safety Cabinets", <http://www.ehs.washington.edu/fsobiocab/focusbsctips.pdf> 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 206-543-0465.

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 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 Principal Investigator (PI) 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 PI must also develop a management plan for the hood which addresses staff training, procedures for using the hood including emergency procedures, ongoing maintenance and 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 Staff Information and Training

All personnel in the laboratory must be trained as to the fact 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 generally are 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.

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 (see Appendix F) if a ventilation system has a problem. When maintenance is scheduled for fume hood exhaust systems, warning signs will be posted on the affected fume hoods and researchers must cease fume hood use during the maintenance procedures in accordance with the requirements listed on the sign.

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 in a notebook or file 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

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 (see 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 impede exiting or make exiting hazardous. For more information see the "Use of Corridors and Unassigned Space" policy.

c. Seismic Bracing and Earthquake Preparedness

Details concerning seismic bracing are noted in Section 9.A.5. Facility Services must perform all facility modification, such as installing mounting brackets on the walls.

d. Plumbing Systems

Place a strainer or mesh pad over all sink drains to prevent objects 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 safe guards to the plumbing system when connecting chemical equipment or experiments to potable water systems. Check with EH&S and Facilities Services prior to any connections to potable water systems.

e. 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 your servicing Facilities Services organization (see 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 206-543-0465. 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 unusual situations, contact EH&S Radiation Safety at 206-543-0463.

f. 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 should not be purchased which produces noise levels greater than 80 dBA without specific written approval from EH&S at 206-543-0465. A formal hearing protection program may need to be implemented for the installation and use of such equipment.

g. 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 at <http://www.ehs.washington.edu/ohs/iaq.shtm> .
- 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 your servicing Facilities Services organization (see Appendix F).
- 3) If an unknown odor persists, contact EH&S at 206-543-0465.

h. Asbestos, Lead and Other Hazardous Laboratory Components

- 1) Asbestos – Asbestos may be found in various equipment components (such as fume hood and safety cabinet wallboard 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 by a work order through Facilities Services. Contact EH&S at 206-543-0465 concerning asbestos questions.
- 2) Lead – Lead may be used in a lab as a barrier when density is needed (such as in an x-ray radiation shield) or as a weight when a heavy material is needed (such as an equipment counter balance). 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 dusts 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 (see Appendix F).

2. Electrical Hazards

Even small electrical currents passing through the body may cause injury or death. Observe the following precautions to reduce electrical risks. Additional information is on the EH&S web page <http://www.ehs.washington.edu/fsophyssafe/electric.shtm>.

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 some 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 (see Appendix F).

c. Equipment Cords and Extension Cords

- 1) Extension cords should be a minimum of 14 gauge size (heavy duty) and be 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 build-in circuit breakers.
- 3) 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. Chemical 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

A facility using water or other liquid conductor that has a likelihood of creating a wet floor or work area should be equipped with GFCI (ground fault circuit interrupter) or equivalent protection 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 with 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 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 a worker 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. If at all 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 and modifications. When repairs and modifications are performed, the energy source must be prevented from being activated using appropriate techniques such as de-energizing the system, inserting blanks into 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. Instruction Manuals

Operator manuals should be available. Workers using the equipment should know where such manuals can be found and should review the manuals prior to using the equipment.

c. 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 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 staff 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 206-543-0465 for space evaluations and to arrange for training.

F. PRESSURE VESSELS AND SYSTEMS

1. Vessels

Pressure vessels, autoclaves, and steam sterilizers operating at pressures greater than 15 pounds per square inch gauge (psig) or larger than six inches in diameter fall within the Washington State Boiler Codes for public spaces. As such, there are strict requirements for design, testing, and approval. The units must be placed on the University's insurance carrier's inspection list maintained by Facilities Services.

2. Pressure Systems

Pressure vessels and systems with operating pressures greater than 15 pounds per square inch gauge (psig) are of potential concern. Design should produce a protection factor of 4:1 up to 10:1 depending upon design parameters and whether the system can be safely tested. A pressure relief device to release safely pressures greater than 10% above the operating pressure should be installed.

3. Precautions

a. Large-Scale Processes

Large-scale processes (exceeding 100 psig or involving more than 10 to 20 grams of reaction compounds) should be carried out in containment devices designed for high pressures.

b. Hazards

Hazards from explosions due to overpressurizations include flying scraps and glass and spills of potentially harmful reaction compounds.

c. Small Scale/Low Pressure Procedures

Avoid damage during small scale/lower pressure procedures. Procedures to avoid damage include the use of barriers, use of undamaged components, use of tubing and glassware designed for the temperatures and pressures involved, and application of the minimal amount of cold (such as by using dry ice) or heat (such as by using low temperature steam) instead of the application of extreme temperatures or spot applications.

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 and 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 workers need to service an area or equipment, ensure the area/equipment is unobstructed, emptied of chemicals, decontaminated, washed with warm-soapy water, and rinsed. The area or equipment must have a posted *Notice of Laboratory Equipment Decontamination Form (UoW 1803)* before service will be provided. This form is available online at <http://www.ehs.washington.edu/forms/fso/lab equip.pdf>.

Facilities Services and maintenance personnel will refuse the work if the area or equipment has not been decontaminated and/or cleaned. Staff 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 staff 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

Laboratory equipment is often contaminated with hazardous materials and/or may be inherently unsafe. UW Surplus Property cannot accept some types of laboratory equipment and cannot accept laboratory equipment containing hazardous materials.

To surplus contaminated or potentially contaminated laboratory equipment, you must first make sure that the equipment is safe for handling and resale by following the directions on the Notice of Laboratory Equipment Decontamination (UoW 1803 at <http://www.ehs.washington.edu/forms/fso/lab equip.pdf>). The Chemical Hygiene Officer (Laboratory Supervisor or PI) must sign the notice to certify that all of the applicable instructions on the form have been followed. Affix the notice to the equipment. Surplus Property will not pick up equipment that does not have this notice attached or does not appear to be clean and empty.

Examples of equipment that must be decontaminated include centrifuges, incubators, fume hoods, cryostats, ovens, BSCs, refrigerators, freezers, sinks, storage cabinets, lockers, bins, and tanks. (Tanks have the potential to be a confined space hazard and thus require special procedures. Call EH&S at 206-543-7388.)

Any equipment capable of generating dangerous radiation or containing radioactive sources must be checked by the EH&S Radiation Safety Office prior to public sale. Please contact the Radiation Safety Office at 206-543-6328. These items include:

- Gas chromatographs
- Germicidal UV lamps
- Lasers
- Scintillation counters

- X-ray equipment
- Any item with a radioactive sticker

The following items CANNOT be accepted by Surplus Property. Contact EH&S Environmental Programs at 206-616-5835 for information on how to dispose of these items:

- Capacitors and transformers (note: 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 by EH&S as being non-PCB oil.)
- Gas cylinders and other pressurized containers/vessels
- Instruments containing mercury
- Equipment containing asbestos, including but not limited to: autoclaves, laboratory ovens, fireproof file cabinets, anything that produces high heat.

The type of decontamination will vary depending on the hazardous material and the type of equipment. Note that personal protective equipment should be used when decontaminating equipment. Below are some requirements and guidelines for decontamination, as well as contact information for questions.

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. See our website at www.ehs.washington.edu/epowaste 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, you must clean the equipment with small amounts of warm detergent water. Avoid splash. Blot dry with paper towels. Commercial radiation decontamination solutions containing chelating agents may be helpful. 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 206-543-6328.

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, BSCs must be decontaminated by EH&S or by a contractor approved by EH&S. For this service, contact EH&S at 206-543-0465.



Section 5 - Employee Health and PPE

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A. ENVIRONMENTAL MONITORING AND MEDICAL SURVEILLANCE

As a general principle, exposures 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 routinely exceeds an exposure limit for a chemical, then the Principal Investigator (PI) or supervisor shall arrange to measure an employee's exposure to that chemical. For assistance in determining if air monitoring should be done, contact EH&S at 206-543-7388. In most cases, EH&S can also perform the air monitoring.

1. Exposure Limits

Exposure limits can be defined by a regulation (identified as a Permissible Exposure Limit (or PEL) or by a guideline. PELs are listed in the Washington Administrative Code (WAC) at WAC 296-841-20025, which can be viewed by going to <http://apps.leg.wa.gov/WAC/default.aspx?cite=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 only about 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-PRODUCING 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 groups, nations, and chemical manufacturers. The recommended limits can be obtained from the publications of those organizations, or may possibly be found on web pages or sometimes listed on material safety data sheets/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 keep exposures and levels as low as feasible.

2. Special Chemical Air Monitoring

Washington State Department of Labor & Industries regulations specifically address the chemicals listed in Table 5-2, Special Chemical Air Monitoring, and require that air monitoring be done. Contact EH&S at 206-543-7388 for assistance if you routinely use any of these chemicals:

Table 5-2 Special Chemical Air Monitoring

Acrylonitrile	1,2-Dibromo-3-chloropropane	Methylene chloride
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 persons in the same laboratory work area have similar complaints.

For specific exposure response procedures, see Section 9 of the Laboratory Safety Manual, the flip chart Emergency Procedures for Laboratories (obtain from EH&S at 206-616-5835) or the poster: <http://www.ehs.washington.edu/manuals/posters/exposureresponseposter.pdf>

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, or 206-598-4848 for UWMC employees). The Occupational Health Nurse will coordinate medical consultation, exams and surveillance.

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

B. PERSONAL PROTECTIVE EQUIPMENT (PPE)

The purpose of PPE is to reduce student and employee exposure to laboratory hazards. It is to be used when substitution or engineering controls are not feasible. Examples of PPE include gloves,

eye and foot protection, respirators, and protective clothing such as aprons and lab coats. See Table 5-3 for example PPE by hazard type.

Principal Investigators (PIs) 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 have used the laboratory PPE Hazard Assessment Guide, <https://www.ehs.washington.edu/fsosurveys/ppetool.docx> as a tool to perform the assessment. EH&S recommends that lab coats and eye protection always be worn when working in the laboratory as best practice.

Before work is initiated, ask to see a copy of the completed assessment or other documents detailing the lab PPE requirements such as standard operating procedures. If PPE is required, the University must provide PPE at no cost to an employee (except for prescription safety glasses and closed shoes). (<http://www.washington.edu/admin/rules/APS/10.04.html>). The PI or 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 common use 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	Splash goggles, gloves, liquid resistant surgical masks, lab coats, aprons, sleeve covers
Chemicals	Gloves, chemical-resistant clothing, aprons, sleeves and shoe covers, vapor-proof or splash goggles; lab coats for general use
Cuts/Abrasions	Cut-resistant gloves (leather, Kevlar, chain-mail)
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
Slipping	Non-skid shoes
Splashes	Splash goggles, face shields, chemical-resistant clothing, gloves, aprons, 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. 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 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 intense light sources such as infrared light, ultraviolet light, glassblowing, welding, and lasers. Glasses, goggles, or face shields with adequate filtration are needed. For assistance, contact EH&S Radiation Safety at 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. The following 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.

- Clothing should cover your legs.
- The 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, polyester and other synthetics are not preferred.
- Loose, flowing garments and scarves should be avoided; they may easily pick up spills or trail through a burner flame.

b. Jewelry

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

c. 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.

d. Laboratory Coats

Laboratory coats are personal protective equipment 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 are required to be provided with and wear a laboratory coat.

Laboratory employees and students should wear laboratory coats or aprons and sleeves whenever there is a potential for contaminating skin or clothing. Laboratory coats that extend to the knees must be worn during any work in the laboratory 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 a laboratory coat than the street clothes, therefore minimizing skin contact with hazardous materials.

There are a number of 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 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.

Laundry requirements are that:

- Laboratory coats must be laundered when soiled or potentially soiled, and on a determined schedule to help ensure they are laundered 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 the University of Washington Consolidated Laundry or similar industrial laundry service. To establish service at UW Consolidated Laundry, contact laundry@uw.edu. Provide them with a contact name, the Department, the box number, the room number, and a budget number. They will send you a nylon bag to collect lab coats for laundry, and a form to complete for the service, including drop off/pick up location and schedule.

3. Gloves

a. When to Wear

Wear gloves whenever working with chemicals, biohazards, radioactive materials, rough or sharp-edged objects, or very hot or very cold materials.

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, door knobs, and elevator buttons, or objects that may be touched without gloves by others.

b. Selection

Select gloves based on the material being handled, the particular hazard involved, and their suitability for the procedures being conducted (such as whether the glove provides appropriate dexterity for the procedures). To select the appropriate chemical-protective glove, see the glove selection chart in Appendix G, read the MSDS, 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.

c. Inspection

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

d. Removal

Take off gloves before leaving the laboratory. If using reusable gloves, wash them with soap and water before removing them, to remove 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 water after removing gloves.

e. Replacement

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

f. 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, see <http://www.ehs.washington.edu/epowaste/chemwaste.shtm>.

g. Latex Gloves

Do not wear thin 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 (Also see Appendix G).

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 UW 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 at <http://www.ehs.washington.edu/ohsresp/index.shtm>. This program includes evaluating hazards and medical fitness of each user, training, selecting equipment and understanding its limits, fit testing, and annual re-certification.

5. Hearing Protectors

Hearing protectors (earplugs or earmuffs) may be needed for some procedures or in some laboratory settings. If you suspect the noise levels may be potentially harmful, contact EH&S at 206-543-7388 for an evaluation. (A rule of thumb is that if you are in a noise environment for most of the day where you have to raise your voice to be intelligible to someone standing next to you, 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 are seen wearing 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 lab coat outside of the laboratory.



Section 6 - Standard Operating Procedures

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A. STANDARD OPERATING PROCEDURES (SOPs)

Laboratories must provide employees with standard operating procedures (SOPs) to be followed when laboratory work involves the use of hazardous substances. 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 Standard Compliance class, which is required for a laboratory's Principal Investigator (PI) or laboratory supervisor/manager. Registration for this class is available online at <http://www.ehs.washington.edu/psotrain/corsdesc.shtm> or call EH&S at 206-543-7201 for more information. For advice in developing SOPs, call EH&S at 206-543-7388 or email uwcho@u.washington.edu.

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 and as long as 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 Material Safety Data Sheets (MSDSs) or 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 web sites, and reference books. An example of this additional information is attached to the Example Benzene SOP, viewable at <http://www.ehs.washington.edu/manuals/lsm/examplesoplms.shtm>.

B. SOP COMPONENTS

Descriptions of the components using a typical SOP design are shown in Figures 6-1 and 6-2, below. An SOP template can be downloaded from <http://www.ehs.washington.edu/manuals/lsm/sop.doc>.

If a "particularly hazardous substance" is involved in the process, expanded requirements must be addressed as shown in the differences between Figure 6-1 and 6-2, below. Particularly hazardous substances include substances that are extremely dangerous or toxic, or are recognized carcinogens or reproductive hazards. The criteria and example list of substances meeting the criteria are available at <http://www.ehs.washington.edu/manuals/lsm/lsmh.shtm>.

1. Process Identification

Identify the name of the process. This could include the chemicals or equipment involved, if that is needed to differentiate the SOP from similar processes.

2. Chemicals and Hazards

Identify the stock chemicals, intermediates, final compounds and wastes involved, and such factors as use of catalysts or inert compounds. 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 least preferred method of protection if alternatives are available. However, when PPE is required, the PPE 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 guidance document for PPE is available on the EH&S web site at <https://www.ehs.washington.edu/fsosurveys/ppetool.docx> and PPE is described in this manual in Section 5.B Employee Health and PPE.

Figure 6-1 Explanation of Elements 1 to 8 on Standard Operating Procedures (SOP) Form

University of Washington

Standard Operating Procedures for Chemicals or Processes	
#1 Process (if applicable)	> <i>The process or type of process that involves the use of hazardous chemicals in the laboratory. Describe in general terms, such as "extraction" and "distillation" or in more detailed terms, such as "spectrophotometer analysis of cholesterol extraction"</i>
#2 Chemicals and Hazards	> <i>For each process, list all chemicals, reactants, and products and describe their hazards. MSDSs/SDSs may be attached.</i>
#3 Personal Protective Equipment (PPE)	> <i>1. List the protective equipment to use; when and why it is worn; how long the equipment will last; and how to store or to take care of the equipment. 2. List unique types of clothing, eye protection, gloves, or respirators required. 3. If respirators are needed, indicate how fit testing will be provided.</i>
#4 Environmental / Ventilation Controls	> <i>List the environmental controls and ventilation systems needed to safely use the chemicals. This may include hoods, environmental rooms, aerosol suppression devices, etc. Describe safety features on equipment.</i>
#5 Special Handling Procedures & Storage Requirements	> <i>Describe any special storage requirements for the chemicals. Include restricted access areas, special containment devices, and safe methods of transportation.</i>
#6 Spill and Accident Procedures	> <i>Indicate how spills or accidental releases should be handled and by whom.</i>
#7 Waste Disposal	> <i>Describe waste disposal procedures for these chemicals. For more information refer to Section 3 of this manual.</i>
#8 Special Precautions for Animal Use (if applicable)	> <i>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.</i>
Particularly hazardous substance involved? (See Lab Safety Manual Appendix H)	
<input type="checkbox"/> YES: Blocks #9 to #11 are Mandatory	
<input checked="" type="checkbox"/> NO: Blocks #9 to #11 are Optional.	
#9 Approval Required	> Optional
#10 Decontamination	> Optional
#11 Designated Area	> Optional
Name:	Title:
Signature:	Date:

Figure 6-2 Explanation of Elements on SOP Form for Particularly Hazardous Substances

University of Washington

Standard Operating Procedures for Chemicals or Processes						
#1 Process (if applicable)	> See Figure 6-1.					
#2 Chemicals and Hazards	> See Figure 6-1.					
#3 Personal Protective Equipment (PPE)	> See Figure 6-1.					
#4 Environmental / Ventilation Controls	> <i>List the environmental controls and ventilation systems needed to safely use the chemicals. This may include hoods, environmental rooms, aerosol suppression devices, etc. Describe safety features on equipment. Provide details of ventilation or equipment (such as glove boxes) used to control the particularly hazardous substance(s).</i>					
#5 Special Handling Procedures & Storage Requirements	> See Figure 6-1.					
#6 Spill and Accident Procedures	> See Figure 6-1.					
#7 Waste Disposal	> <i>Describe waste disposal procedures associated with the particularly hazardous substance(s). Include disposal of items contaminated by the particularly hazardous substance(s), such as supplies used to clean up spills.</i>					
#8 Special Precautions for Animal Use (if applicable)	> See Figure 6-1.					
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td rowspan="2" style="width: 40%; text-align: center;">Particularly hazardous substance involved? (See Lab Safety Manual Appendix H)</td> <td style="width: 15%; text-align: center;"><input checked="" type="checkbox"/> YES:</td> <td style="text-align: center;">Blocks #9 to #11 are Mandatory</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/> NO:</td> <td style="text-align: center;">Blocks #9 to #11 are Optional.</td> </tr> </table>		Particularly hazardous substance involved? (See Lab Safety Manual Appendix H)	<input checked="" type="checkbox"/> YES:	Blocks #9 to #11 are Mandatory	<input type="checkbox"/> NO:	Blocks #9 to #11 are Optional.
Particularly hazardous substance involved? (See Lab Safety Manual Appendix H)	<input checked="" type="checkbox"/> YES:		Blocks #9 to #11 are Mandatory			
	<input type="checkbox"/> NO:	Blocks #9 to #11 are Optional.				
#9 Approval Required	> <i>Indicate if the process/chemical procedure requires prior approval. Describe the approval process.</i>					
#10 Decontamination	> <i>Describe decontamination procedures for equipment and glassware. Include glove boxes, restricted access hoods, perchloric acid fume hoods, etc.</i>					
#11 Designated Area	> <i>Indicate where the "designated area" is for the particularly hazardous chemical(s) being used. The entire laboratory, a fume hood, or a portion of the laboratory can be labeled as a "designated area".</i>					
Name: _____ Title: _____						
Signature: _____ Date: _____						

4. Environmental / Ventilation Controls

Describe engineering controls to be used to minimize exposures, including fume hood, glove box, or 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. Refer to Appendix H for definitions and a partial list of the “particularly hazardous substances.” These additional details should address using specific containment device(s) such as fume hoods or glove boxes.

5. Special Handling Procedures & Storage Requirements

Describe administrative controls such as transportation in secondary containment within or outside the laboratory space, 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 the best practices that would be used to minimize accidents, such as placing temporary signs warning of hazards when personnel may be absent.

Specify if there are limits to the amount of reactants during the process. This also provides guidance for chemical purchases. For example, purchase the smallest quantity necessary where possible. Describe storage requirements, such as the use of secondary containment, or storage in locked cabinets.

If “particularly hazardous substances” will be used, consider restricting non-essential personnel from the area.

6. Spill and Accident Procedures

Describe how spills or accidental releases should be handled and by whom. Provide guidance as to limited capabilities, such as a spill of 100 ml in a fume hood may be easily handled by staff whereas a spill of 10 ml outside the hood may not be safely handled.

7. Waste Disposal

Describe waste disposal procedures for all wastes. 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. This includes describing procedures to neutralize or treat wastes to make handling safer or to reduce the amount of hazardous waste. EH&S has preferred treatment options on the web page concerning waste minimization (<https://www.ehs.washington.edu/epohazreduce/index.shtml>).

Provide additional details if “particularly hazardous substances” (highly toxic or dangerous chemicals, carcinogens, reproductive toxicants or select toxins) are used. Refer to Appendix H for definitions and a partial list of the “particularly hazardous substances.” These additional details should address additional procedures for decontamination and safely handling contaminated waste materials.

8. Special Precautions for Animal Use (if applicable)

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 being allowed to perform the procedure, operation or activity. An example could be that a worker 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. Maintain written 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

Example SOPs are available on the EH&S web site (at <http://www.ehs.washington.edu/manuals/lsm/examplesoplins.shtm>). If used by your laboratory, these examples must be modified and customized as necessary 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 uwcho@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

EH&S recommends you review and modify any generic SOPs that pertain to your laboratory. This allows you to become familiar with the required elements, as described above in Figures 6-1 and 6-2.

2. Step 2 – Identify Requirements

Identify if any particularly hazardous substances (see Appendix H) 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 the 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 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 a number of similar procedures are performed using similar substances.

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. Ensure all elements of the SOPs are addressed if the SOP pertains to chemicals considered particularly hazardous (those that have a high degree of acute toxicity, are especially dangerous or are select carcinogens or reproductive toxins, such as those listed in Appendix H and similar substances).

4. Step 4 – File the SOPs

After completing the SOPs, file the master copies so that everyone can find 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 located.

5. Distributing Copies of the SOPs

If you provide working copies of your SOPs to your staff, keep track of how many copies you made and distributed. When you make changes, you will need to assure that the up-dated SOPs reach all those who perform the procedures.

If you develop an SOP which you believe can be used by other departments in the University, please forward a copy electronically to the University's Chemical Hygiene Officer at uwcho@u.washington.edu.

6. Update SOPs as Needed

If you note changes to your process or chemical use, which impact an SOP or recognize improvements that can be made to the SOP, update it as soon as it is convenient. Note the revision date on the SOP.

Notify all lab personnel of the revised SOP. Replace the previous SOP in your files and anywhere else they may have been placed, including the work copies which would be referred to on a daily basis by your staff and those which may be kept at the lab benches or in individual staff members' files.



Section 7 - Safety Training

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A. SAFETY TRAINING REQUIREMENTS

According to state/federal laws and University of Washington policy, PIs and laboratory supervisors are responsible for ensuring that all employees receive adequate training in order to understand the hazards present in their work area. Training must occur prior to assignments involving new hazards. Refresher training or retraining may be required by law and for personnel who demonstrate that they did not understand the initial training or are not following required procedures.

The 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 that they too are aware of the hazards and of how to protect themselves while in the work area.

The University of Washington takes the responsibility of employee safety very seriously. Mandatory safety training is a key component of this commitment. (Administrative Executive Order No. 55 of the President, is available at <http://www.washington.edu/admin/rules/policies/PO/EO55.html> .)

Additional training may be required for laboratory research that is outside the scope of EH&S, for example research involving animal subjects, clinical research, funded research, etc. UW Research maintains a Required Training web page to help researchers comply with external sponsor and internal training requirements at <http://www.washington.edu/research/compliance/required-training/> .

B. EH&S SAFETY TRAINING AND RECORDS

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 training matrix is available on the EH&S training page at: <http://www.ehs.washington.edu/forms/psotrain/ehslabsafetytrainmatrix.pdf> .

EH&S maintains training records for all EH&S provided classes. Individuals may look up their training records and print certificates by using the My EHS Training tool and logging in with their UWNetID at <http://www.ehs.washington.edu/psotrain/mytraining.shtm>. Departments or units may request a copy of staff training records by contacting EH&S Training at 206-543-7201 or ehstrain@uw.edu.

C. LABORATORY-SPECIFIC TRAINING AND RECORDS

Additional laboratory or worksite specific training by the PI/supervisor is also required.

The laboratory PI 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 should be noted in the Laboratory-Specific Information section of the Chemical Hygiene Plan.

The laboratory PI or supervisor must also keep a copy of safety training content, such as 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 Department of Labor and Industries inspections, to help in training new employees, and in providing refresher training if needed.

Training records should be maintained for as long as any particular trained employee remains employed in the work area. 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. Employee training may be documented using forms such as the examples in Appendix C.

D. UW OFFICE OF RESEARCH - RESEARCH REQUIRED TRAINING

The Office of Research collected research-related required training links from University departments (EH&S included) on to one site to help researchers comply with external sponsor and internal requirements and/or reduce risk. Extensive data work has also provided access to training transcripts for all research-related required training on this site <http://www.washington.edu/research/compliance/required-training/> .



Section 8 - Record Keeping

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A. CURRENT RECORDS MAINTAINED IN THE LABORATORY/DEPARTMENT

1. Chemical Hygiene Plan

The Chemical Hygiene Plan, comprised of the online UW Laboratory Safety Manual plus the laboratory-specific information such as Standard Operating Procedures, laboratory floor plans, chemical spill kit locations, and emergency procedures must be accessible to all employees in the laboratory at all times that 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 Chemical Hygiene Plan must be reviewed and **updated at least annually** by the PI or laboratory supervisor, and the review should be recorded in the laboratory-specific information area.

2. Chemical Inventory

Current chemical inventories must be maintained on the UW MyChem system for each laboratory. A copy should be printed annually for easy reference. The current inventory could be filed in the laboratory-specific information area or in another location. All workers must know where the inventory is maintained. (EH&S also recommends that the PI or laboratory manager have a current copy available at home in case of emergencies.)

3. Material Safety Data Sheets/Safety Data Sheets (MSDSs/SDSs)

Material Safety Data Sheets / Safety Data Sheets must be maintained for hazardous products. Departments are encouraged to maintain accessible copies of MSDSs/SDSs for immediate reference in case of emergencies and for training purposes. The master file of MSDSs/SDSs for all known chemicals used on campus is maintained by EH&S and electronic copies of individual MSDSs/SDSs are immediately available on MyChem. See also the MSDS/SDS section 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 Principal Investigator or laboratory supervisor should keep copies of all incident/accident reports filed pertaining to the laboratory or involving laboratory staff.

5. Safety Training Records

Laboratories must maintain records of all work-related safety and health training. (Refer to Section 7.D for information on what to include in your laboratory training documentation.)

EH&S maintains records of attendance at their classes. University personnel can check their records using their UWNetID and this link <http://www.ehs.washington.edu/psotrain/mytraining.shtm>. Copies of these records are available to departments upon request (call 206-543-7201 or email ehstrain@u.washington.edu).

The *UW Office of Research* collected research-related required training links from several departments onto one site to help researchers comply with external sponsor and internal requirements and/or reduce risk. Extensive data work has also provided access to training transcripts for all research-related required training on this site at <http://www.washington.edu/research/compliance/required-training/>.

6. Shipping Papers (Bills of Lading)

If chemical-containing items are mailed or moved on or off campus and require shipping papers, these papers should be kept for one year.

7. Chemical Treatment Log

You must keep a log of all hazardous wastes that you have treated, and provide it to EH&S upon request. An example chemical treatment log can be found on the EH&S website: <http://www.ehs.washington.edu/forms/epo/chemlog.pdf>. Keep these logs for three 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 after the exposure.

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 and training documents for individuals who have left the department.

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 others that is reported to EH&S.

b. Medical Records

Occupational health medical records for employees are maintained for Environmental Health and Safety in the Hall 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.



Section 9 - Emergency Preparedness and Response

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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, your building Emergency Evacuation and Operations Plan, and the UW Emergency Response Management Plan.

Principal Investigators 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 employees must be informed about laboratory emergency procedures as part of their new employee orientation. All staff should participate in periodic drills and exercises, including “table top” discussions, to keep knowledge current and interest fresh.

1. Planning and Prevention

Emergency response on the Seattle campus is provided by the University of Washington Police Department and Seattle Fire Department. Local fire and police departments respond at Bothell, Tacoma, and off-site locations. EH&S will provide liaison with these organizations and provide advice, but each laboratory is responsible for accident prevention, and preparing for laboratory emergencies.

a. Accident Prevention

Help to prevent emergencies in laboratories and minimize the effects of an emergency by doing the following:

- 1) Post emergency phone numbers and the Emergency Procedures for Laboratories flip chart
- 2) Identify the locations of emergency equipment on a floor plan; make sure all staff know the locations of the equipment such as a spill kit
- 3) Know locations of shutoffs for equipment including electrical, gas, and water
- 4) Train personnel to retrieve MSDSs/SDSs for laboratory chemicals
- 5) Separate incompatible chemicals
- 6) Frequently dispose of chemical wastes, and clean out unneeded chemicals and surplus or dispose of unneeded items
- 7) Ensure electrical wires and equipment are in good condition
- 8) Discuss accidents and near misses to prevent future accidents
- 9) Complete the laboratory inspection checklist periodically

- 10) Discuss safety topics periodically in staff meetings

b. Hazards Assessment /Risk Minimization

When a new experiment or process is in development, assess possible hazards and identify ways to reduce risks. This is the responsibility of the Principal Investigator (with assistance from the Chemical Hygiene Officer if other than the Principal Investigator.) However, laboratory personnel are more likely to comply with the experimental procedures when they are involved with their development, and they may provide good perspective too.

Information about hazards and controls are available in the product SDS/MSDS, from colleagues and from EH&S (call 206-543-7388 or email uwcho@u.washington.edu for advice.)

c. 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 closed
- 6) Practice good housekeeping, such as recycling empty cardboard boxes and 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 staff as to the chemicals, their hazards and precautions. Document the training. Exercise responses occasionally.

d. 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 laboratory's processes (see Section 6 of this manual). Pay special attention to additional precautions that may be desirable for pyrophoric, water reactive,

and oxidizing chemicals, and those that may generate toxic gases if a reaction were to occur.

Chemicals should be acquired in small quantities for ease of handling and 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.

e. 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/MSDSs for emergency response personnel.

Heavy or hazardous items that could topple over and create a hazard or block emergency exits must be secured to the walls or floor. These items include shelving units, equipment racks, and file cabinets taller than 4 feet, distillation units, gas cylinders, and cryogenic dewars. Anchors for these items must be secured to the walls or floor by Facilities Services. Two straps are recommended 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 two-inch tall lip or protective restraint devices to prevent chemical containers from being thrown off the shelf. Cabinets used to store chemical containers should have a closure device to prevent the door from being shaken open.

f. Gas Leaks and Unknown Odors

All staff need to know what gases and volatile chemicals in their laboratory may produce an odor. Identify contents of pipes, hoses or gas lines with labels. Staff should know the location of control valves used to shut off gas flow. Discuss previous incidents with odors as well as possible odors from adjacent laboratories during staff meetings if they are issues.

g. Utility Outages: Pre-planning and Mitigation

- 1) To pre-plan for utility failure, consider the utilities laboratory operations depend on and 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 systems
 - 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 be taken beforehand to mitigate the effects of shutdowns on laboratory operations include:
- Maintain backup (split) samples at another location
 - Maintain records at another location
 - Use emergency power circuits (if available) only for equipment that needs it
 - Install devices to improve services, such as water filters for potable water and surge protectors or Uninterruptible Power Systems for electrical power
 - Plan the steps that need to be taken to safely shut the process(es) down and start it (them) up again
 - Plan what actions would be needed to prevent uncontrolled reactions
 - Contract for emergency supplies and services. For example, if refrigerators or freezers are used for specimens, locate a source 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 which detect power interruptions and alert the designated person. Being alerted to an outage does not solve the problem but it can give employees extra time to react.
 - Develop procedures for card reader doors and other security systems that typically have a four-hour battery backup and procedures to communicate changes to normal access routes if necessary
 - Have flashlights in areas that do not have emergency lighting and periodically check their condition
 - Be aware of the various alarm systems and the appropriate responses to them (including fire alarms, ventilation system alarms, fume hood low flow alarms, gas leak detection systems.)
 - Advise staff that communication channels set up for other disaster situations (adverse weather) will be used during long-term power outages
 - Maintaining good habits for safe chemical use, such as keeping containers closed
 - Conduct periodic trainings, drills or exercises.

h. Unattended Operations and Floods

Avoid leaving operations or experiments unattended. Post on the door to the room the name and phone number of the person responsible for the operation 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.

Water should never be left running unattended. Water can flood into the floor below your laboratory; in fact, this happens too often. If it is necessary to have water running unattended, install a commercially available 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 to become brittle than rubber tubing. If using tubing, make sure the ends are tightly connected and tied tight. Anchor outlet hoses into sinks or drains.

Do not leave open flames unattended.

i. Inclement Weather

Plan for inclement weather, including lightning, heavy snow, hail or ice storms, high winds, heavy rainfall, flooding, and even high heat loads, depending on the laboratory's location.

Staff must have an emergency kit on campus and should have emergency kits at home. Laboratory-specific planning should include determining how communications between separated staff will occur and determining what procedures may be affected. If an activity must continue on a daily basis, such as an experiment or caring for research animals, devise a contingency plan for inclement weather. Consider who could travel to the laboratory and provide the necessary service. Realize that certain roads and building entrances that you usually use may not be available.

Plan for these events by considering the following beforehand:

- 1) How to protect personnel.
- 2) How to shut down experiments in a timely manner or safely continue experiments in emergency conditions.
- 3) How to protect experimental results and essential materials.
- 4) How to protect equipment and supplies from the weather.

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 EH&S and the Office of Emergency Management web sites.

In general, laboratory security can be improved if all 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 out materials which may be attractive to thieves
- 6) Properly dispose of hazardous agents which are 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 only designated personnel.

The PI, with the assistance of the department, should determine policies to increase security. All staff must be periodically reminded of these policies.

k. Field Operations

Plan for emergencies that may occur during field operations, it is desirable to write a safety plan. Take 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 access to first aid, CPR and medical response and have a first aid kit available
- 3) Determine communications to be used in case of emergency
- 4) Devise alternative plans for inclement weather
- 5) Develop checklists to ensure necessary supplies and equipment are brought to the site
- 6) The UW no longer offers a field trip insurance program for students. Students should check their insurance coverage before participating in lab activities.

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

Many safety equipment providers offer spill cleanup supplies or kits. To purchase a UW specific general-purpose spill kit through EProcurement, visit the EH&S page at https://www.ehs.washington.edu/epo/spills/vwr_ordering_spills.shtm for instructions. This general-purpose kit is also available for purchase through either BioChemistry Stores (Health Sciences J-014) or Chemistry Stores (Bagley Hall 036) under part number 4227. Table 9-1 identifies the components of the UW specific general-purpose spill kit. Each lab should tailor their kit to their specific operations.

Table 9-1 General Purpose Chemical Spill Kit Contents

Item	Description
Absorbent	Five spill pads, universal for acid, base, oil, solvents
Neutralizer	One 64 oz. box baking soda for neutralizing acids
Brush, dustpan	One snap together dust pan and whisk broom
Plastic bags	Four 18 x 30, yellow hazardous material heavy duty waste bags
Plastic drum	One 5-gallon re-useable screw top plastic drum to store kit supplies and hold bagged spill waste
Goggles	One chemical splash protection goggles
Impervious gloves	One pair Silvershield gloves (multi-layer construction, impervious to most chemicals)
Lightweight gloves	Eight pairs of Microgrip powder-free nitrile gloves, various sizes
Forms	EH&S Chemical Collection Request and hazardous waste labels

b. Mercury Spill Kits

Many safety providers offer Mercury spill kits. To purchase the UW specific Mercury Spill Kit through EProcurement, visit the EH&S page https://www.ehs.washington.edu/epo/spills/vwr_ordering_spills.shtm for specific instructions. The kit may also be purchased at either BioChemistry Stores (Health Sciences J-014) or Chemistry Stores (Bagley Hall 036). Table 9-2 lists the contents of the Mercury Spill Kit are listed below:

Table 9-2 Mercury Spill Kit Contents

Item	Description
Scraper	One plastic scraper
Syringe	One 1 cc syringe to aspirate visible mercury droplets
Amalgamating powder	One package, Hg-Absorb powder to amalgamate micro-droplets
Sponge	One sponge to wipe surfaces after using Hg-Absorb powder
Plastic bag	One 9 x 12 reseal-able bag for waste (holds kit contents)
Gloves	One pair, Nitrile gloves, large size
Forms	Chemical Collection Request and hazardous waste labels

c. Biological Spill Kits

Information on biological spill kits is located on the EH&S web site at <http://www.ehs.washington.edu/rbsbiosafe/spillbiokit.shtm>.

d. First Aid Kits

First aid supplies must be readily accessible to employees while working in the lab. The size of a first aid kit can be related to the number of people who may use the kit, as shown in the following table (Table 9-3, Typical First Aid Kit Contents). Each laboratory must establish procedures to assure that first aid kits remain stocked.

Table 9-3 Typical First Aid Kit Contents

Required Items	# People		
	1 - 5	6 - 15	16 -30
Absorbent gauze 2'x6'	0 pk	1 pk	2 pk
Adhesive bandages 1"	1 bx	1 bx	2 bx
Bandage compress 4"	1 pk	2 pk	2 pk
Eye dressing	0 pk	1 pk	1 pk
Scissors and tweezers	1 pk	1 pk	1 pk
Triangle bandages	1 pk	2 pk	6 pk
Antiseptic soap/pads	1 pk	1 pk	1 pk
Kling bandage 4"	1 dz	1 dz	1 dz

Surgipad dressing	2 ea	2 ea	3 ea
Adhesive tape	1 pk	1 pk	1 pk
Multi-trauma dressing	0 ea	1 ea	1 ea
Kerlix dressing 3"	0 pk	1 pk	1 pk

The kit contents may vary depending on particular laboratory situations.

For example, 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 it could be kept in a spill kit or another location close to the work area and known by all personnel). The gel has a relatively short shelf life of six months so the PI/laboratory supervisor needs to replace it periodically. (See <http://www.ehs.washington.edu/manuals/focus/hf.pdf> for additional details about procuring the gel from a local vendor.)

e. Disaster Kits

Disaster kit information is on the UW Emergency Management web site at http://www.washington.edu/emergency/prepare/disaster_kit.php.

B. RESPONSE TO SPECIFIC INCIDENTS / ACCIDENTS

Emergencies occur in a range of severity. Minor incidents such as an insignificant spill, or such as a scratch treated by applying a “band aid,” do not need a major response. All personnel need to know what to do in case of a major emergency.

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 Department of Labor and Industries regulations (Washington Administrative Code, WAC 296-800-320).

a. Chemical Exposure

If a hazardous chemical is in someone’s eyes, flush eyes for at least 15 minutes in the eyewash, holding the victim’s eyelids open. Call 911 as soon as possible.

If a toxic or corrosive chemical is on someone’s skin, flush area affected for at least 15 minutes. If necessary, use the safety shower and remove contaminated apparel. (For hydrofluoric acid, when calcium gluconate treatment is available, instead flush skin for five minutes and immediately apply the calcium gluconate. For more details, see the HF example Standard Operating Procedure.) 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 MSDS/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.

b. 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. 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.

All faculty, staff, students and visitors are required to report an accident or incident using the online accident reporting system within 24 hours of the incident or accident if a person was injured or property damage occurred. Also report any on-the-job incident that barely missed causing an injury or illness or property damage. The online system is available at <http://www.ehs.washington.edu/ohsoars/index.shtm>.

c. 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. Also, notify UW Risk Management at 206-543-0183. More information is available at <http://f2.washington.edu/treasury/riskmgmt/wc>.

2. Fires and Explosions

In the event of a fire or explosion, activate the alarm system and evacuate as soon as possible. You may attempt to use an appropriate fire extinguisher to fight the fire if it is easily extinguished (*i.e.*, smaller than a trashcan), you have been trained within the last year on how to use a fire extinguisher and you have a clear exit.

If a person's hair or clothing is on fire, smother the flames with a coat or by having the person roll on the floor. Call 911 and provide first aid. Assist to evacuate as needed. Remain in contact with emergency responders.

Report all fires and explosions immediately. Even if the fire was small, contained and readily extinguished by laboratory personnel, and you did not call 911, immediately report the incident to the University Police on the Seattle campus at 206-685-UWPD (8973). At UW Bothell, call the UW Bothell Public Safety Department at 425-352-5222. At UW Tacoma, call the Campus Safety Services at 253-692-4416.

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.

Submit an accident report on the online accident reporting system on the EH&S web site at <http://www.ehs.washington.edu/ohsoars/index.shtm>.

3. Spills

Your response to a spill depends on the danger it poses. Immediately assess the situation to determine if anyone has been exposed and to assess whether clean-up is within the laboratory staff's capabilities. Guidance is available on the "Emergency Procedures for Laboratories" flip chart. Chemical spills advice is available on the EH&S web page <https://www.ehs.washington.edu/epo/spills/chemspills.shtm>.

a. Documentation and Process Improvement

After the incident, fill out an accident report (on the EH&S Web site at <http://www.ehs.washington.edu/ohsoars/index.shtm>) with your supervisor. 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 Standard Operating Procedure(s).

b. 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 others from entering the area, and take care not to contaminate materials such as shoes. Refer to the EH&S web page <https://www.ehs.washington.edu/epo/spills/hgspills.shtm> for detailed guidance.

4. Earthquake Response

Drop, Cover, and Hold On! 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. Aid injured if you are able. Determine if you need to evacuate the work area. When evacuating, take keys, emergency kits, etc. because you may not be allowed to re-enter until the building has been assessed for hazards. Try to note the extent of building damage while evacuating. Assemble at the Evacuation Assembly Point. Await further instructions. Do not re-enter the building until after it has been assessed for structural damage by trained personnel and re-entry is authorized by University officials. For further information about earthquake safety, see guidelines on the EH&S web page: <http://www.ehs.washington.edu/fsoemerprep/earthquake.shtm> and the UW Emergency Management web page: <http://www.washington.edu/emergency/>.

5. 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 Facilities Services (see 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 at <http://www.ehs.washington.edu/ohsoars/index.shtm>.

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.8.d. If an immediate source can not be found 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 – such as whether it smells like a sewer, or rotting food, or over-heating electronics, or 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.

If the odor isn't immediately found but appears to be appreciably stronger in one location, there is likely a source nearby, which can be a dried sink drain or floor drain (if a sewer-like or chemical-like odor), a chemical process gone wrong (if a rotting or unknown chemical odor), over-heating electronics (if devices are over-heating), or a chemical spill or a leaking process (if a distinct chemical). There are an unlimited number of potential sources, but familiarity with the lab's activities should help narrow the possibilities.

Additional general information about indoor air quality is available on the EH&S web site at <http://www.ehs.washington.edu/ohs/iaq.shtm>.

6. Utility Outage

The safety of you and 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 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 exiting, not routine work.

If the failure appears likely to last for a long period, follow your health and safety plan and directions of your department/supervisor. Keep refrigerator and freezer doors closed for as long as possible 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.

a. Electrical Failure Procedures

- 1) Assess the extent of the outage in your area.
- 2) On a UW campus, report the outage to Facilities Services (see phone numbers in Appendix F). If in a leased facility off-campus, report the outage to the servicing electrical utility and to the building owner.
- 3) Help co-workers in darkened work areas move to safe locations.
- 4) Implement pre-planned response actions, as necessary. Do not treat the outage as "business as usual."
- 5) If practical, secure current experimental work, then move it to a safe location.

- 6) Close any open containers of hazardous materials.
- 7) Close sashes on fume hoods and biological safety cabinets.
- 8) If you move chemicals on carts between floors, get assistance. Hazardous spills are a significant risk during transport.
- 9) Keep lab refrigerators or freezers closed throughout the outage.
- 10) Unplug personal computers, non-essential electrical equipment, and appliances.
- 11) Open windows for additional light and ventilation (during mild weather).
- 12) If you are asked to evacuate your building, secure any hazardous materials work and leave the building.
- 13) To obtain information about a prolonged outage, listen to service announcements in the local media or call the service provider.
- 14) Release personnel during an extended outage if directed to do so by the department director.
- 15) When power is restored, immediately assess the affected area for potentially hazardous situations, such as devices left "on." This is also required if power is restored at a time that the facility would be normally unoccupied.

b. HVAC/Fume Hood Failure Procedures

- 1) Notify other occupants of the situation.
- 2) If necessary (*e.g.*, because smoke is coming into the room), evacuate area (and pull fire alarm if the situation is widespread)
- 3) Notify your supervisor or building coordinator of the situation.
- 4) Shut down work in progress if safe to do so:
 - Shut off equipment and supplied gases and liquids
 - Close open containers
 - Close sashes on fume hoods, biological safety cabinets
 - Note the step in your process when work was stopped
 - Return specimens to freezer, storage containers, *etc.*
- 5) Open windows if staff are to remain in the workplace.
- 6) If staff remain in the workplace, periodically check on their wellbeing and evacuate if anyone is adversely affected.
- 7) Prior to re-starting work in the area, review work to identify possible hazards.
- 8) If the outage caused damage, submit an accident report on the online accident reporting system at <http://www.ehs.washington.edu/ohsoars/index.shtm>.

7. Laboratory Floods

If your laboratory is flooded, find the source of the water. 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. Then, 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 (see Appendix F) if at other locations. Also, notify the supervisor, principal investigator 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.

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 (fabrics and cardboard, for example) 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 at <http://www.ehs.washington.edu/ohsoars/index.shtm>.

8. 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 if there is a possibility of getting swept off the roadway. Minimize your driving and your lab staff's driving during heavy snow, ice storms and extreme icing conditions. Listen to the radio (KOMO 1000AM or other more current radio station as listed on the Office of Emergency Management web page or the UW information line at 206-UWS-INFO) for instructions pertaining to University operations and use email and telephones to maintain contact with your department and laboratory staff.

9. Intruders, Suspicious Packages and Demonstrators

Contact your servicing police department immediately to report a suspicious intruder or there is something missing. If a person is acting in a way that indicates he or she 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 you see wiring, or hear noise 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 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, see the US Postal Service Poster on Suspicious Packages online at: <http://about.usps.com/posters/pos84.pdf>

In case of a demonstration adjacent to your laboratory, do not provoke, obstruct, or get into a verbal altercation with the demonstrators. If necessary, simply 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 see 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 direction of the police or your evacuation warden.

In all cases, submit an accident report on the online accident reporting system at <http://www.ehs.washington.edu/ohsoars/index.shtm>.



Section 10 - Moving In / Moving Out

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A. MOVING IN: OCCUPYING A NEW OR REMODELED LABORATORY

Occupants moving into new or remodeled laboratory space must comply with many health and safety regulations designed to keep workers safe. See the EH&S Moving In Checklist (Appendix E) for a comprehensive list of requirements and recommendations for moving into a new laboratory.

1. Before the Move

a. Clearing of laboratory by previous occupants

If possible, visit your space in advance to ensure that it has been completely decontaminated and cleared for reuse. See the Moving Out Checklist in Appendix E for more details. If you believe that the space is still contaminated or has not been properly

cleared out, contact that building's Building Coordinator immediately for assistance in locating the department and researcher previously occupying the room.

b. Laboratory design

If you are modifying an existing laboratory or constructing a new one, refer to the University of Washington Laboratory Safety Design Guide, online at <http://www.ehs.washington.edu/fsodesignrev/labsafdesign.shtm>. The Guide outlines requirements and recommendations for new laboratories. For further information about laboratory equipment installation, testing and approvals, contact EH&S at 206-543-0465.

Facilities Services must be used 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. To request work, contact them as described in 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. Also ensure that any fume hoods and biosafety cabinets have been certified by EH&S.

If your laboratory does not meet your needs, consider obtaining access to another laboratory's equipment or space. For example, 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; see Section 4, Equipment and Facilities, for more information about equipment approved for purchase at the University of Washington. New fume hoods and biosafety cabinets must be tested and certified by EH&S before use.

d. Transporting and storing hazardous materials

Plan ahead about how and where you will transport and store your materials and equipment so that you can pack and unpack most efficiently. You must not block hallways, doorways or emergency equipment while packing or unpacking. Special arrangements must be made with a hazardous materials mover for chemicals, gasses, and other hazardous materials. Call EH&S at 206-616-5835 for assistance with moving arrangements for hazardous materials. Call 206-543-0463 for assistance with moving radioactive materials.

Finally, refer to the Moving In Checklist in Appendix E of this manual. Many items in that checklist can or must be completed before you move in.

2. After the Move

Use the Moving In/New Laboratory Checklist in Appendix E of this manual to help you fulfill all health and safety requirements. Start filling out this checklist as early as possible; some items should be completed weeks or even months in advance of your move.

Once you have moved in and completed the checklist, consider regularly using the more detailed Annual Laboratory Self –Assessment Checklist, also in Appendix E, to evaluate overall conditions and practices in the laboratory.

3. Checklist for Moving Into a Laboratory

A comprehensive checklist for moving in is in Appendix E of this manual.

B. MOVING OUT: VACATING A LABORATORY

Whether a laboratory is being completely vacated 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 you must decontaminate all work surfaces. You must also remove all equipment (unless arrangements have been otherwise) and any garbage or other items that will not be wanted by the new occupants. 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 our Moving Out Checklist in Appendix E as a tool for making sure that all requirements associated with moving out are completed. Thorough planning of a laboratory move is essential. EH&S recommends that each laboratory or department develop a list of all the tasks and which people are assigned to each task.

The responsibilities of the Principal Investigator, Department, Project Manager (if there is one) and EH&S are listed below.

1. Responsibilities

a. Principal Investigator

The Principal Investigator 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 PI is required to remove the hazards associated with his/her work and to provide information about potential hazards (or lack thereof) remaining in the space. The PI is responsible for ensuring the removal of all chemical, biological, and radioactive materials and their residues from the labs in which their work was conducted. The PI may delegate tasks to lab staff and colleagues appropriate to their level of training, knowledge, and ability to address them; however, in all cases, it remains the PI's responsibility to assure tasks are completed satisfactorily according to the guidelines and specified protocols.

b. Project Manager

The Project Manager is responsible for ensuring that all steps of a construction or remodeling project are completed. For department-managed projects, this person may be a department employee, and for Facilities Services projects, this person may be a Facilities Services employee. Either entity may contract for project management services; if they do, then it is the contracted individual who assumes responsibility for assuring project tasks are completed according to plan and schedule.

c. Department

The department is responsible for ensuring that Principal Investigators and designated Project Managers manage laboratory closures or moves responsibly. In the event a PI is no longer available to fulfill his or her duties, then the department must ensure the completion of tasks ordinarily assigned to the PI. 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.

Departments also retain records about chemical exposure and other chemical safety issues. Records retention is discussed in Section 8 - Record Keeping.

d. EH&S

EH&S is available for advising a Department, PI or Project Manager on environmental, health and safety-related aspects of laboratory deactivations and moves.

- If laboratory operations have involved radioactive materials, please refer to the Radiation Safety Manual and the Moving Out Checklist in Appendix E of this manual for additional EH&S roles in laboratory closures.
- If laboratory operations have involved biological materials, please refer to the Biological Safety Manual and the Moving Out Checklist in Appendix E of this manual 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. Moving companies and UW Property & Transport Services are not authorized to move hazardous substances (see next subsection for information about moving hazardous substances).

Moving companies are also not authorized to remove materials and equipment that are attached to the building (e.g. removing a laboratory bench from a wall) or would impact the building materials (e.g. removing a cork board that is glued to the wall). Facilities Services or a contractor managed through Capital Projects Office must be hired for tasks involving removal of materials and equipment attached to the walls and floors and electrical and plumbing work. To request this work from Facilities Services, refer to Appendix F.

Lab equipment must be decontaminated before it is moved. Information on decontamination is in Sections 4.G. and 4.H of this manual and online at http://www.ehs.washington.edu/forms/fso/lab_equip.pdf.

b. Moving Hazardous Materials

Investigators have the options of moving their hazardous chemicals themselves with the guidance of EH&S or of hiring through EH&S a hazardous materials contractor.

If you choose to move your 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 mentioned above apply along with four additional 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, and
- 4) You must let EH&S know what you will be moving.

The chemicals must be in DOT-approved containers. EHS will loan you DOT-approved containers upon request.

EH&S can also arrange for a hazardous material contractor to pack and/or transport your chemicals for you. The contractor will not move any hazardous wastes.

Again, anyone deciding to move hazardous chemicals without the assistance of movers must contact EH&S for guidance before attempting the move. Call 206-616-5835 or email chmwaste@u.washington.edu for more information.

c. Moving Radioactive Materials

For short moves of radioactive materials between locations on the contiguous UW Seattle campus, an investigator may choose to “hand carry” these materials to a new location. Radioactive materials transported in this manner shall be in a closed container and contain diatomaceous earth or similar absorbent in order to mitigate any possible spill.

For any move of radioactive materials over public roads or long enough distances to require the use of a vehicle, contact EH&S to complete the move (206-543-0463). Radioactive materials must never be transported by laboratory personnel in either private vehicles or university vehicles. All vehicular transport of radioactive materials must be performed by EH&S staff.

d. Moving Biological Materials

When transporting biological materials, follow the instructions in Appendix C of the UW Biosafety Manual, online at: http://www.ehs.washington.edu/rbsbiosafe/BSM_AppC.pdf.

e. Moving Freezers

The moving company cannot move any freezers containing materials that would be 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. Specialized moving companies can move freezers and dewars that do not contain infectious materials. Call 206-616-5835 or email chmwaste@u.washington.edu for more information.

3. Checklist for Laboratory Moveouts

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 has been developed to facilitate this process and 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. The form can be found at the following link: <http://www.ehs.washington.edu/forms/fso/1800.pdf>



Appendix A:

296-828 WAC (Washington Administrative Code)

Hazardous Chemicals in Laboratories

Washington Industrial Safety & Health Act (WISHA)
Department of Labor & Industries
May 2014

The following pages are from:

http://www.lni.wa.gov/safety/rules/chapter/828/WAC296-828.PDF#WAC_296_828_100

Chapter 296-828 WAC
Safety Standards for Hazardous Chemicals in Laboratories
(Form Number F414-135-000)

LAST UPDATED 05/01/2014

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 May 2014. 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 E-MAIL UPDATES:

- Sign up for our Listserv at www.Lni.wa.gov/main/Listservs/SafetyStandards.asp

TO PRINT YOUR OWN PAPER COPY OR TO VIEW THE RULE ONLINE:

- Go to: <http://www.lni.wa.gov/Safety/Rules/Find/>

TO REQUEST A SAFETY CD THAT INCLUDES ALL OF OUR RULES:

- E-mail your CD request to: RulesRequests@Lni.wa.gov

TO REQUEST A HARD COPY:

- E-Mail your mailing address and the book request to: rulesrequest@lni.wa.gov

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 phone number is 1-800-4BESAFE

Also available on the WISHA web site:

<ul style="list-style-type: none">• WISHA Core Rules• Other General WISHA Rules• Industry and Task-Specific Rules• Proposed Rules and Hearings• Newly Adopted Rules and New Rule Information	<ul style="list-style-type: none">• WISHA Regional Directives (WRDs)• WISHA Interim Operations and Interpretive Memoranda (WHM)• Memoranda of Understanding (MOU)
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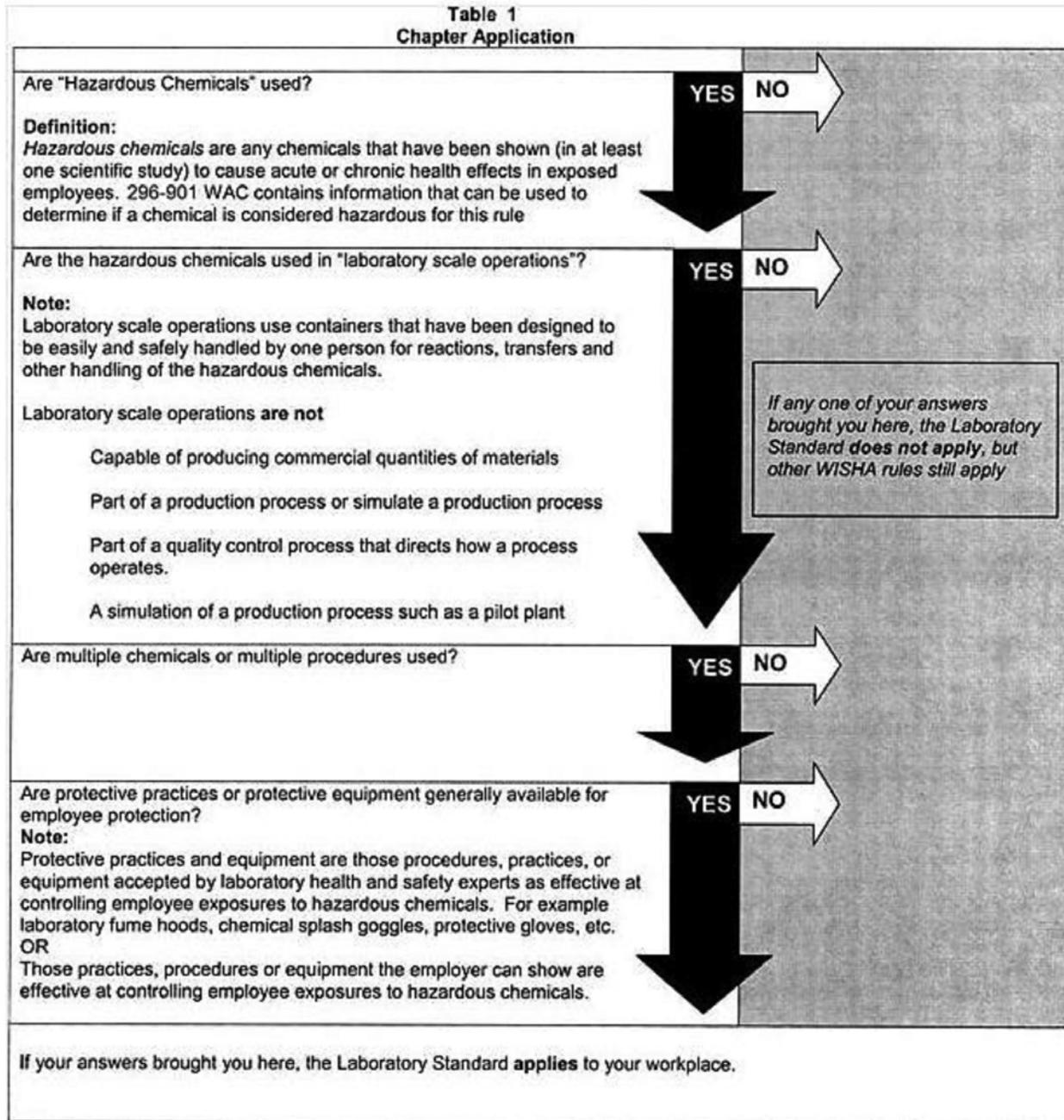
HAZARDOUS CHEMICALS IN LABORATORIES
Chapter 296-828 WAC

LAST UPDATED 05/01/2014

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WAC 296-828-100 Scope

This Chapter applies to the laboratory use of hazardous chemicals. To determine if this Chapter applies to your workplace, use Table 1



WAC 296-828-100 (Cont.)

IMPORTANT:

- When your laboratory operation is covered by this Chapter, and you use any of the substances in Table 2, the following applies with the exception of formaldehyde use in histology, pathology, and anatomy laboratories. In histology, pathology, and anatomy laboratories you must follow the requirements in chapter 296-856 WAC, Formaldehyde. This chapter applies to all other formaldehyde laboratory uses as defined in Table 1:
 - The exposure limits and any requirement protecting employees from skin and eye contact in the rules listed in Table 2 will still apply.
 - Where the action level (or where no action level exists, the permissible exposure limit) is exceeded for a substance listed in Table 2, the exposure evaluation and medical surveillance requirements in the substance rule will still apply.
 - You are not required to meet other requirements of the substance rule.
- To get the permissible exposure limits (PELs) for hazardous chemicals used in your laboratory, see Chapter 296-841 WAC, Airborne contaminants.

Table 2 WISHA Regulated Hazardous Chemicals
Acrylonitrile
Arsenic (inorganic)
Asbestos
Benzene
Utadiene
Cadmium
Coke ovens
Cotton dust
1, 2-Dibromo-3-chloropropane
Ethylene oxide
Formaldehyde
Lead
Methylene chloride
Methylenedianiline
Vinyl chloride
Ionizing radiation
4-Nitrobiphenyl

WAC 296-828-100 (Cont.)

Table 2 WISHA Regulated Hazardous Chemicals
Alpha-Naphthylamine
4,4' Methylene bis (2 - chloroaniline)
Methyl chloromethyl ether
3,3'-Dichlorobenzidine (and its salts)
Bis-Chloromethyl ether
Beta-Naphthylamine benzidine
4-Aminodiphenyl
Ethyleneimine
Beta-Propiolactone
2-Acetylaminofluorene
4-Dimethylaminoazobenzene
N-Nitrosodimethylamine

[Statutory Authority: Statutory Authority: RCW 49.17.010, .040, .050, and .060. 10-15-106 (Order 10-15), § 296-828-100, filed 07/20/10, effective 09/01/10. Statutory Authority: RCW 49.17.010, .040, .050, and .060. 07-05-062, 07-06-005 (Order 06-38), § 296-828-100, filed 02/20/07, effective 04/01/07. Statutory Authority: RCW 49.17.010, .040, .050, and .060. 06-02-060 (Order 05-19), § 296-828-100, filed 01/03/06, effective 04/01/06.]

WAC 296-828-200 Using Hazardous Chemicals in Laboratories

Your responsibility:

To protect employees from laboratory use of hazardous chemicals

WAC 296-828-20005
Chemical hygiene plan

WAC 296-828-20010
Exposure evaluation

WAC 296-828-20015
Training

WAC 296-828-20020
Labeling and safety data sheets (SDSs)

WAC 296-828-20025
Chemicals produced in laboratories

WAC 296-828-20030
Medical evaluations

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 14-07-086 (Order 13-08), § 296-828-200, filed 03/18/14, effective 05/01/14. Statutory Authority: RCW 49.17.010, .040, .050, and .060. 06-02-060 (Order 05-19), § 296-828-200, filed 01/03/06, effective 04/01/06.]

WAC 296-828-20005 Chemical Hygiene Plan

You must

- Develop and carry out a written chemical hygiene plan (CHP) that will protect your employees from hazardous substances in the laboratory and keep exposure levels below those listed in chapter 298-841 WAC, Airborne contaminants.
- Make sure the written plan is readily available to employees and their representatives.
- Include the following elements in your written CHP:
 - The names or job titles of the chemical hygiene officer, other personnel responsible for implementing the CHP, or when appropriate, the members of a chemical hygiene committee
 - Standard operating procedures that provide employee protection when working with hazardous substances
 - Criteria for how you will select and use control measures to reduce employee exposures to hazardous chemicals, especially chemicals known to be extremely hazardous
 - Additional employee protection for select carcinogens, reproductive toxins, and chemicals with high degree of acute toxicity. The following will be considered, when appropriate:
 - The establishment of exposure control areas
 - Containment devices, such as fume hoods or glove boxes
 - The safe removal of contaminated waste
 - Procedures for decontamination
 - Specific measures to make sure fume hoods and other protective equipment provide proper and adequate performance and are properly functioning
 - The circumstances when specific laboratory operation, activity, or procedure requires prior approval from the employer or their designated representative before implementation
 - A description of how you are going to train and inform your employees about laboratory use of hazardous chemicals
 - A description of your provisions for medical consultations and medical examinations
- Review and evaluate the effectiveness of your written CHP at least annually and update as necessary.

Reference:

- *This publication can provide you with additional information to help you with your written chemical hygiene plan:*
 - *National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington, DC, 1995.*

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 07-05-062, 07-06-005 (Order 06-38), § 296-828-20005, filed 02/20/07, effective 04/01/07. Statutory Authority: RCW 49.17.010, .040, .050, and .060. 06-02-060 (Order 05-19), § 296-828-20005, filed 01/03/06, effective 04/01/06.]

WAC 296-828-20010 Exposure Evaluation

IMPORTANT:

- For any of the specific substances listed in Table 2 of the scope of this Chapter, you need to follow the exposure evaluation procedures found in the Chapters regulating those substances if employee exposure routinely exceeds the AL or PEL. For all other employee exposures follow this section to determine exposure evaluation procedures.

You must

- Determine if you could have a respiratory hazard as described in Chapter 296-841 WAC, Airborne contaminants.

Reference:

- *For additional requirements relating to airborne contaminants , see:*
 - Chapter 296-841 WAC, Airborne contaminants
 - Chapter 296-842 WAC, Respirators
 - The specific rule for your chemical

You must

- Provide written notification of exposure monitoring results to employees represented by your exposure evaluation, within 5 business days after the results become known to you.

Note:

- *You can notify employees either individually or by posting the notification in areas readily accessible to all affected employees.*
- *Posted notifications may need information that allows affected employees to determine which monitoring results apply to them.*
- *Notification may be:*
 - *In any written form, such as hand-written or e-mail.*
 - *Limited to the required information, such as exposure monitoring results.*

Reference:

- *For additional requirements relating to employee exposure records, go to chapter 296-802 WAC, Employee medical and exposure records.*

[Statutory Authority: RCW 49.17.010, .020, .040, .050, and .060. 07-03-163 (Order 06-30), § 296-828-20010, filed 01/24/07, effective 04/01/07. Statutory Authority: RCW 49.17.010, .040, .050, and .060. 06-02-060 (Order 05-19), § 296-828-20010, filed 01/03/06, effective 04/01/06.]

WAC 296-828-20015 Training

You must

- Inform employees about the presence of hazardous chemicals at the following times:
 - At the time of initial assignment to a work area where hazardous chemicals are present
 - Prior to situations involving a new exposure to hazardous chemicals

- Train employees on all of the following:
 - Methods and observations for detecting the presence or release of hazardous substances. Examples of these methods and observations may include:
 - Monitoring conducted by you
 - Continuous monitoring devices
 - Visual appearance or odor of hazardous chemicals when being released.
 - The physical and health hazards of chemicals in the work area
 - The procedures and measures employees can use to protect themselves from hazardous substances. Examples of these include:
 - Appropriate work practices
 - Emergency procedures
 - Personal protective equipment

- Provide refresher training to fit your needs

- Provide information to employees on all of the following:
 - The contents of this Chapter and where to find a copy
 - Permissible exposure limits found in Chapter 296-841 WAC, Airborne contaminants
 - Any recommended exposure levels for compounds without an exposure limit in the WISHA rules. Examples include:
 - The PELs found in the National Institute for Occupational Safety and Health (NIOSH) NIOSH Pocket Guide to Chemical Hazards 2004
 - or**
 - The American Conference of Governmental Industrial Hygienists (ACGIH®) Documentation of the Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs), 7th Edition.

 - Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory.
 - Where to find a copy of:
 - Your chemical hygiene plan
 - Safety data sheets (SDSs), including those received from the chemical suppliers
 - Reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 14-07-086 (Order 13-08), § 296-828-20015, filed 03/18/14, effective 05/01/14. Statutory Authority: RCW 49.17.010, .020, .040, .050, and .060. 07-03-163 (Order 06-30), § 296-828-20015, filed 01/24/07, effective 04/01/07. : Statutory Authority: RCW 49.17.010, .040, .050, and .060. 06-02-060 (Order 05-19), § 296-828-20015, filed 01/03/06, effective 04/01/06.]

WAC 296-828-20020 Labeling and Safety Data Sheets (SDSs)

You must:

- Make sure labels on incoming containers are not removed or defaced.
- Keep and make available to employees any SDS received with an incoming container of hazardous chemicals.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 14-07-086 (Order 13-08), § 296-828-20020, filed 03/18/14, effective 05/01/14. Statutory Authority: RCW 49.17.010, .040, .050, and .060. 06-02-060 (Order 05-19), § 296-828-20020, filed 01/03/06, effective 04/01/06.]

WAC 296-828-20025 Chemicals Produced in Laboratories

You must

- Follow Table 3 for chemical substances produced in your laboratory.

Table 3 Lab Produced Chemical Substance Requirements	
If	Then
The chemical is a hazardous chemical	Follow all appropriate requirements of this Chapter
A chemical by-product is produced and its composition is unknown	Assume it is a hazardous chemical and Follow your chemical hygiene plan to protect employees
You produce chemicals in your laboratory for users outside the laboratory	Follow WAC 296-901-14014, Safety data sheets and WAC 296-901-14012, Labels and other forms of warning

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 14-07-086 (Order 13-08), § 296-828-20025, filed 03/18/14, effective 05/01/14. Statutory Authority: RCW 49.17.010, .040, .050, and .060. 06-02-060 (Order 05-19), § 296-828-20025, filed 01/03/06, effective 04/01/06.]

WAC 296-828-20030 Medical Evaluations

IMPORTANT:

- For any of the specific substances listed in Table 2 of the scope of this Chapter, you need to follow the medical evaluation procedures found in the Chapters regulating those substances if employee exposure routinely exceeds the AL or PEL. For all other employee exposures follow this section to determine medical evaluation procedures.

You must

(1) Make medical evaluations available when:

- An employee develops signs or symptoms associated with a hazardous substance from laboratory exposure.
- Any emergency situation that could cause a hazardous exposure, such as a spill, leak, or explosion, occurs.
- A medical provider recommends a follow-up evaluation.
- Exposure monitoring for any of the substances found in Table 2 reveals exposures routinely over the action level (AL) or in the absence of an AL the permissible exposure level (PEL).

(2) Make sure medical evaluations are provided at reasonable times and places, and at no cost to employees.

WAC 296-828-20030 (Cont.)

Note: This includes travel costs and wages associated with any time spent obtaining the medical evaluation.

You must

- Provide the LHCP the following information before the medical evaluation is performed:
 - The name of the hazardous chemicals the employee may have been exposed to:
 - Any signs or symptoms of exposure the employee has.
 - A description of the conditions under which the exposure occurred.
 - The exposure monitoring results for the conditions, if available.
- Obtain the LHCP's written opinion for each medical evaluation that includes the following:
 - Recommendations for medical follow-up
 - Any medical conditions found that would increase the employee's risk for impairment from exposure to a hazardous chemical
 - A statement that the employee has been informed of exposure-related medical results and conditions that require further examination or treatment
 - A written opinion that does not contain any medical information unrelated to the employee's occupational exposures
- If the written opinion contains any medical information unrelated to occupational exposures, return it to the LHCP and obtain a revised version without the additional medical information

Reference: For additional requirements relating to employee medical records, go to chapter 296-802 WAC, Employee medical and exposure records.

[Statutory Authority: RCW 49.17.010, .020, .040, .050, and .060. 07-03-163 (Order 06-30), § 296-828-20030, filed 01/24/07, effective 04/01/07. Statutory Authority: RCW 49.17.010, .040, .050, and .060. 06-02-060 (Order 05-19), § 296-828-20030, filed 01/03/06, effective 04/01/06.]

WAC 296-828-300 Definitions

Action level - An airborne concentration of a hazardous substance that is calculated as an 8-hour time-weighted average, and initiates certain requirements to be followed such as exposure monitoring or medical surveillance.

Carcinogens - See "Select carcinogen"

Chemical hygiene officer - An employee designated by the employer who is qualified by training or experience to provide technical guidance in the development and implementation of the chemical hygiene plan. This definition is not intended to place limitations on the designated employee's position description or job classification within the employer's organization.

Chemical hygiene plan - A written program developed and implemented by the employer that establishes procedures, equipment, personal protective equipment, and work practices to protect employees from the health hazards of the chemicals used in the laboratory.

WAC 296-828-300 (Cont.)

Container - Any container, except for pipes or piping systems that contains a hazardous substance. For example it can be any of the following:

- Barrel
- Bottle
- Can
- Cylinder
- Drum
- Reaction vessel
- Storage tank

Day - Any part of a calendar day.

Designated representative - Any one of the following:

- Any individual or organization to which an employee gives written authorization
- A recognized or certified collective bargaining agent without regard to written employee authorization
- The legal representative of a deceased or legally incapacitated employee.

Emergency - Any event that could or does result in the unexpected, significant release of a hazardous substance. Examples of emergencies include equipment failure, container rupture, or control equipment failure.

Exposure - The contact an employee has with a hazardous substance, whether or not protection is provided by respirators or other personal protective equipment (PPE). Exposure can occur through various routes of entry such as inhalation, ingestion, skin contact, or skin absorption.

Hazardous chemical - Means any chemical which is classified as health hazard or simple asphyxiant in accordance with the Hazard Communication Standard, WAC 296-901-140.

Health hazard - Means a chemical that is classified as posing one of the following hazardous effects: Explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid, or gas); self-reactive; pyrophoric (gas, liquid, or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; in contact with water emits flammable gas; or combustible dust. The criteria for determining whether a chemical is classified as a physical hazard are in Appendix B of the Hazard Communication Standard, WAC 296-901-14024 and 296-901-14006 (definitions of "combustible dust" and "pyrophoric gas").

Laboratory - A facility where the "laboratory use of hazardous substances" takes place. A workplace where relatively small amounts of hazardous substances are used on a nonproduction basis.

Laboratory-type hood - A device located in a laboratory, enclosure on 5 sides with a moveable sash or fixed partial enclosed 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.

Note: Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that 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 substances.

WAC 296-828-300 (Cont.)

Laboratory scale - Work with substances in which the containers used for reactions, transfers and other handling of the substances are designed to be easily and safely manipulated by one person. "Laboratory scale" **does not** include workplaces producing commercial quantities of materials.

Laboratory use - The handling or use of hazardous substances that includes **all** the following:

- Chemical manipulations conducted on a "laboratory scale"
- Multiple chemical procedures or chemicals are used
- The procedures are not part of a production process, nor in any way simulate a production process.
- "Protective laboratory practices and equipment" are available and are commonly used to minimize the potential for employee exposures to hazardous substances.

Licensed healthcare professional (LHCP) - An individual whose legally permitted scope of practice allows him or her to provide some or all of the healthcare services required for medical evaluations

Mutagen - Means chemicals that cause permanent changes in the amount or structure of the genetic material in a cell. Chemicals classified as mutagens in accordance with the Hazard Communication Standard, WAC 296-901-140 must be considered mutagens for purposes of this section.

Permissible exposure limits (PELs) - PELs are employee exposures to toxic substances or harmful physical agents that must not be exceeded. PELs are also specified in WISHA rules found in other chapters.

Physical hazard - Means a chemical that is classified as posing one of the following hazardous effects: Explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid, or gas); self-reactive; pyrophoric (gas, liquid, or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; in contact with water emits flammable gas; or combustible dust. The criteria for determining whether a chemical is classified as a physical hazard are in Appendix B of the Hazard Communication Standard, WAC 296-901-14024 and 296-901-14006 (definitions of "combustible dust" and "pyrophoric gas").

Protective laboratory practices and equipment - Laboratory procedures, practices, and equipment accepted by laboratory health and safety experts as effective, that can be shown to be effective, in minimizing the potential for employee exposure to hazardous substances.

Reproductive toxin - Mean chemicals that affect the reproductive capabilities including adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring. Chemicals classified as reproductive toxins in accordance with the Hazard Communication Standard, WAC 296-901-140 shall be considered reproductive toxins for purposes of this section.

Safety data sheet (SDS) - Written, printed, or electronic information (on paper, microfiche, or on-screen) that informs manufacturers, distributors, employers or employees about a hazardous substance, its hazards, and protective measures as required by safety data sheet and label preparation, WAC 296-901-14012 and 296-901-14014.

Select carcinogen - Any substance meeting one of the following criteria:

- Regulated by WISHA as a carcinogen
- Listed in the "known to be carcinogens" category in the latest edition of the Annual Report on Carcinogens by the National Toxicity Program (NTP).
- Listed in Group I (carcinogenic to humans) in the latest editions of the International Agency for Research on Cancer (IARC) Monographs.

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- Listed in either group 2A or 2B by IARC or in the category “reasonably anticipated to be carcinogens” by the NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
 - After an inhalation exposure of 6 to 7 hours a day, 5 days a 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.

Time-weighted average (TWA₈) - An exposure limit averaged over an 8-hour period that must not be exceeded during an employee's workday.

[Statutory Authority: RCW 49.17.010, .040, .050, and .060. 14-07-086 (Order 13-08), § 296-828-300, filed 03/18/14, effective 05/01/14. Statutory Authority: RCW 49.17.010, .020, .040, .050, and .060. 07-03-163 (Order 06-30), § 296-828-300, filed 01/24/07, effective 04/01/07. Statutory Authority: RCW 49.17.010, .040, .050, and .060. 06-02-060 (Order 05-19), § 296-828-300, filed 01/03/06, effective 04/01/06.]



Appendix B - Glossary

This glossary contains common terms found in the Laboratory Safety Manual and on Material Safety Data Sheets (MSDSs) / Safety Data Sheets (SDSs). Another valuable source for information about MSDS/SDS entries can be found at the web site <http://www.ilpi.com/msds/ref/index.html>.

absolute	A chemical substance that is not mixed; pure. For example Absolute Alcohol, ethyl 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, http://www.acgih.org)
acids	Any chemical which 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 which forms 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.
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.
anorexia	Loss of appetite.
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, http://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 asphyxiants 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.
autoignition 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.
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 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, <http://www.cas.org>)

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" should be the units digit in the sum. For example, CAS number 591-78-7 is incorrect, because $(8 \times 1) + (7 \times 2) + (1 \times 3) + (9 \times 4) + (5 \times 5)$ equals $8 + 14 + 3 + 36 + 25$ which equals 86. So the "z" should 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 University of Washington 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.
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-hour toll free telephone number (800-424-9300), intended primarily for use by those who respond to chemical transportation emergencies. (http://www.chemtrec.org/Chemtrec/)
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 University of Washington, 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 University CHO (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 University of Washington 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. CO ₂ will not burn and is relatively nontoxic (although high concentrations, especially in confined spaces, can create hazardous atmospheres and breathing difficulties).
COC	Cleveland Open Cup. A flash point test method.
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.
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 which 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.
DHHS	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.
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-digit numbers, 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.
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 Hall Health, 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-butyl acetate, with examples shown in Table B-1:

Table B-1 Evaporation Rate Examples

	Evaporation Rate	Examples
Fast	> 3.0	Hexane - 8.3 Acetone - 5.6 Methyl ethyl ketone (MEK) - 3.8
Medium	0.8 to 3.0	Methyl isobutyl ketone (MIBK) - 1.6 190-proof (95%) Ethyl alcohol-1.4 VM&P naphtha - 1.4
Slow	< 0.8	Xylene - 0.6 Water - 0.3 Mineral spirits - 0.1

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.

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 several flash point test methods and flash points may vary for the same material depending on the method used, so the test method is indicated when the flash point is given.
formula	The conventional scientific designation for a material (water is H ₂ O, sulfuric acid is H ₂ SO ₄ , sulfur dioxide is SO ₂ , etc.).
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. Note: Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that 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.
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 http://www.unece.org/trans/danger/publi/ghs/ghs_rev01/01files_e.html .
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 Hazard Communication Standard at WAC 296-839-20005 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.
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.
highly dangerous	Chemicals which have extreme hazard due to flammability or reactivity. The criteria for being considered highly dangerous at the University of Washington is an NFPA rating of "4" for flammability or a reactivity rating of "3" or "4."
highly toxic	<p>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:</p> <ul style="list-style-type: none">• Oral route: LD₅₀ of 50 mg/kg or less when administered to albino rats weighing 200-300 grams each.• 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.• 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.
IARC	International Agency for Research on Cancer. One of the sources that OSHA refers to for data on whether a material is a carcinogen. (http://www.iarc.fr/) (A subsidiary agency of the World Health Organization, with US offices at 525 23 rd Street NW, Washington DC 20037, 202-974-3000, http://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 206-543-0465 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.
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.
Laboratory Safety System	The precursor to MyChem. No longer in use. See "MyChem."
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 LC ₅₀ 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/m ³) 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 LD ₅₀ 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 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.
LSS	Laboratory Safety System. The name of the computer network database which has been upgraded and is now the MyChem system. See "MyChem."
malaise	A feeling of general discomfort, distress, or uneasiness; an out-of-sorts feeling.
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.

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.
MSDS	Material Safety Data Sheet. A document describing a chemical's known hazards, which is produced by the chemical manufacturer and provided to the chemical user but now being replaced by Safety Data Sheets (SDSs) as required by OSHA.
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 MSDSs/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.
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 should 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, 16 volumes of 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. (http://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.

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. http://www.osha.gov/ . Alternatively, the Occupational Safety and Health Act (1970), the federal act requiring worker protection programs.
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.” A partial list is provided in Appendix H.
PEL	Permissible Exposure Limit. 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. 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).
phlegm	Thick mucous 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).

PI	Principal Investigator. The senior researcher who has control over a laboratory's spaces and processes.
PMCC	Pensky-Martens Closed Cup. A flash point test method.
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	A general term for the reuse of wastes, it includes reclamation and recovery.
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.
S or "Skin"	A notation found in MSDSs/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	See "SDS."
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."
select carcinogen	Any chemical that meets one of the following criteria: <ul style="list-style-type: none">• It is regulated under WISHA as a carcinogen;• 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);• It is listed under Group I ("carcinogenic to humans") by the International Agency for Research on Cancer (IARC) Monographs (latest editions); or• 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:<ul style="list-style-type: none">○ 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;○ 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.
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 LD ₅₀ 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.
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.

SETA	Setaflash Closed Tester. A flash point test method.															
“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.															
solubility in water	<p>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:</p> <table><tr><td>Negligible</td><td>=</td><td>Less than 0.1 percent;</td></tr><tr><td>Slight</td><td>=</td><td>0.1 to 1.0 percent;</td></tr><tr><td>Moderate</td><td>=</td><td>1 to 10 percent;</td></tr><tr><td>Appreciable</td><td>=</td><td>More than 10 percent;</td></tr><tr><td>Complete</td><td>=</td><td>Soluble in all proportions.</td></tr></table>	Negligible	=	Less than 0.1 percent;	Slight	=	0.1 to 1.0 percent;	Moderate	=	1 to 10 percent;	Appreciable	=	More than 10 percent;	Complete	=	Soluble in all proportions.
Negligible	=	Less than 0.1 percent;														
Slight	=	0.1 to 1.0 percent;														
Moderate	=	1 to 10 percent;														
Appreciable	=	More than 10 percent;														
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 other specified temperature. If a volume of a material weighs 8 pounds, and an 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 gravity 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 MSDS/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) should be stated on the chemical’s MSDS/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.															
TAG	Tagliabue Closed Tester. A flash point test method.															

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 LD ₅₀ of 50-500 mg/kg when administered orally to albino rats weighing 200-300 grams each, (b) an LD ₅₀ 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 LC ₅₀ 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.”
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.”

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 University of Washington policies, available at http://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 MSDSs/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.
WAC	Washington Administrative Code. The compilation of regulations written by State of Washington regulatory agencies. WACs can be reviewed online at http://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 http://www.lni.wa.gov/Safety/Rules/Find/WACNumber/default.htm .
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.

Appendix C - Templates for Lab Specific Information

Contents

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B. LABORATORY FLOOR PLANS	4
C. TRAINING DOCUMENTATION FORMS	5

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Figure C-3	Example Chemical Safety Training Log.....	6
Figure C-4	UW Laboratory Employee Safety Training Checklist.....	7

A. LABORATORY-SPECIFIC INFORMATION

The following pages contain templates and examples that can be used to note laboratory-specific information that is required to complete your lab's Chemical Hygiene Plan (CHP). These templates are also available as documents which can be downloaded from the EH&S web pages, from <http://www.ehs.washington.edu/manuals/lsm/index.shtm> .

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.

If you have paper copies of your laboratory-specific information, you should typically file these pages in the front of the safety manual for easy reference, or maintain them in a location that everyone knows is the location of the laboratory-specific information for your CHP. If you keep electronic copies of all or some of your laboratory-specific information, everyone in the lab must know which are the current files, and how to access them.

Figure C-1 Laboratory-Specific Information

(Begins on next sheet)

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

On:

By:

The items listed below identify our laboratory-specific information that is attached (or filed in its noted location), and that applies to our laboratory:

✓	Laboratory-specific information cover sheet (<i>i.e.</i> , these pages)
✓	Laboratory floor plan(s)
	General laboratory safety rules, applicable at all times in our laboratory
	Designations of individuals performing particular tasks (e.g., checking first aid supplies, maintaining chemical inventories, weekly eyewash check, etc.)
	Authorizations for individuals to use specific hazardous/controlled substances
	Any special instructions for receiving and storing hazardous materials
	Contents of chemical spill kit(s)
	Any special instructions for labeling containers
✓	Training records, or location if filed separately from this Plan
✓	Standard Operating Procedures (SOPs), or location if filed separately
✓	MyChem Chemical Inventory Report, or location if filed separately
	Locations of MSDSs, other reference materials, University or departmental safety rules that apply to us, equipment maintenance manuals, other paper documents (such as a building evacuation plan or departmental health and safety plan) if filed separately from this CHP, etc.

B. LABORATORY FLOOR PLANS

Draw a floor plan for each room that is covered by this manual. Place it/them in the My Lab Specific section at the front of this manual. Note the locations of any signs, safety equipment and process-related equipment that may be present. Please see the examples of such equipment, and an example floor plan, in Figure C-2.

Eyewash Stations

Emergency Showers

Fire Extinguishers

First Aid Kits

Flammable Liquid Storage Cabinets

Glove Boxes

Any other specialized equipment or operation with safety implications.

Emergency Phone Number Signs

Direction of Exit

Gas Shut-Off Valves for Benches

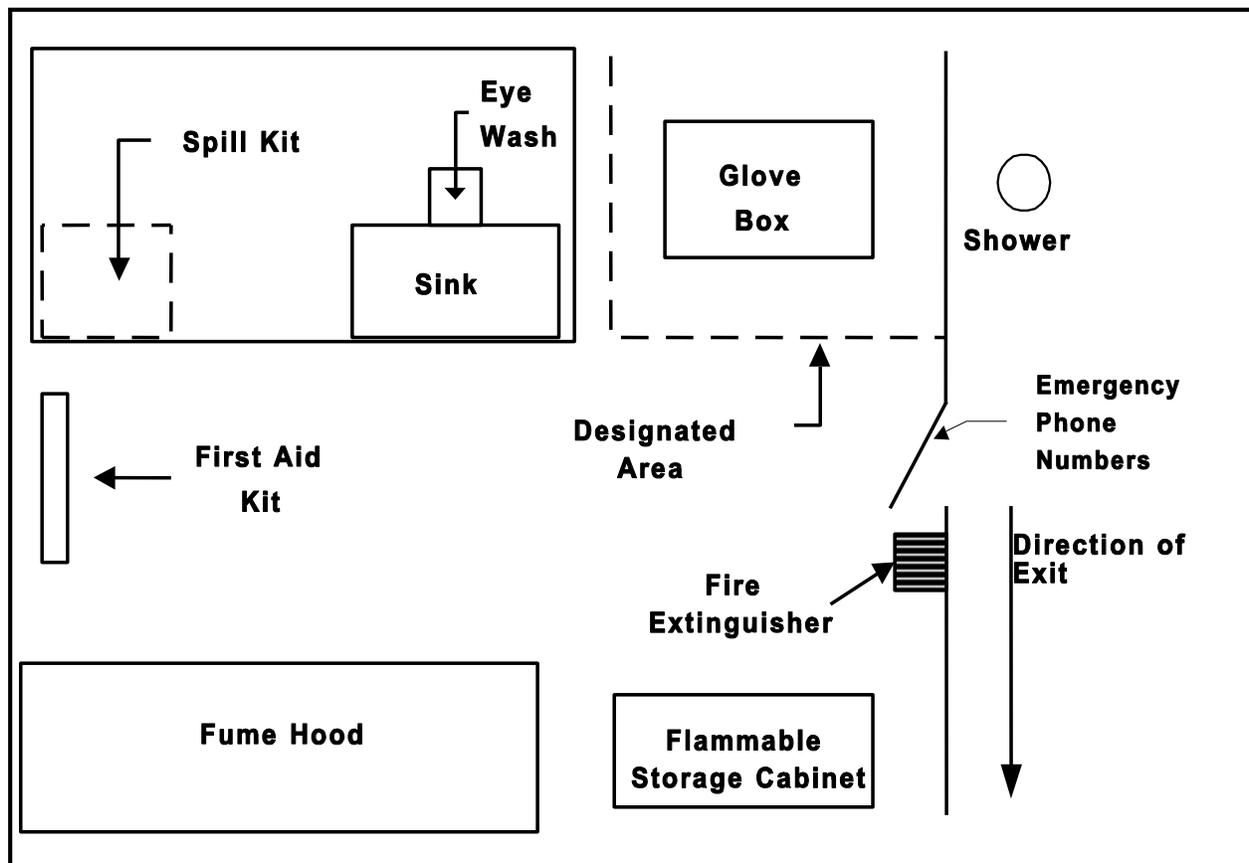
Ventilation Systems

Spill Kits

Electrical Panels/Circuit Boxes

(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-2 Example Floor Plan



C. TRAINING DOCUMENTATION FORMS

The following page (Figure C-3, Example Chemical Safety Training Log for Groups) shows an example form which could be used to document training. After being filled out to describe a training session, this form could be filed in the laboratory-specific information section or in a department's filing scheme. If filed separately from the laboratory-specific information section, the filing location should be noted in the laboratory-specific information section.

Two forms are available to track individualized training. The Safety Training for Laboratory Personnel matrix form identifies EH&S training classes available based on an individual's duties, and is at <http://www.ehs.washington.edu/forms/ps0/ehslabsafetytrainmatrix.pdf>.

Another available form is the UW Laboratory Employee Safety Training Checklist, which can also be used to plan, track and document the laboratory-specific training received by a specific individual, Figure C-4 beginning on page C-8 below. A "pdf" version of this form is available at <http://www.ehs.washington.edu/forms/ps0/labemployeesafetytrain.pdf> for your use.

Figure C-4 UW Laboratory Employee Safety Training Checklist**UW LABORATORY EMPLOYEE SAFETY TRAINING CHECKLIST**

According to state/federal laws and University of Washington policy, Principal Investigators and laboratory supervisors are responsible for ensuring that all employees receive adequate training to understand the hazards present in their work area. This includes administrative personnel who handle lab chemicals for such tasks as receiving, inventory, and stocking. Training must occur prior to assignments involving potential exposure to chemicals. EH&S provides general training for most categories of hazards in the laboratory. EH&S strongly encourages and in some cases requires that employees take these classes since they cover topics that are specific to the University of Washington and Washington state. Laboratory staff must also receive training applicable to all UW employees such as an orientation to the department Health and Safety Plan, Emergency Evacuation and Operations Plan, Asbestos General Awareness, Violence Prevention, etc.

Employee Name: _____ **Date:** _____

Supervisor Name: _____ **Date:** _____

Laboratory Specific Training		
<i>The below types of training are required for each laboratory staff person and are to be provided by the Laboratory P.I., Manager, or Chemical Hygiene Officer. Details about each subject are discussed in Section 7 of the UW Laboratory Safety Manual, online at http://www.ehs.washington.edu/manuals/lsm/index.shtm.</i>		
Have you received the following?		Date
Orientation to the content and location of the Chemical Hygiene Plan, including: <ul style="list-style-type: none"> • UW Laboratory Safety Manual • Lab-specific Standard Operating Procedures (SOPs) • Other lab specific information 	<input type="checkbox"/> YES	
Methods for finding exposure limits	<input type="checkbox"/> YES	
Material Safety Data Sheets/Safety Data Sheets (MSDSs/SDSs) and other safety references	<input type="checkbox"/> 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	<input type="checkbox"/> YES	
Requirements for Personal Protective Equipment (PPE) and how to select, don, doff, and maintain it	<input type="checkbox"/> YES	
How to segregate and safely store chemicals in the laboratory	<input type="checkbox"/> YES	
Proper disposal of all laboratory waste	<input type="checkbox"/> YES	
How to safely clean up spills and respond to other emergencies	<input type="checkbox"/> YES	

EH&S Laboratory Safety Training	
<i>Answer the following questions. If YES, fill in the date when the training is completed. For more information about the classes, see http://www.ehs.washington.edu/psotrain/index.shtm or contact the EH&S Training Office at ehstrain@u.washington.edu or 206.543.7201.</i>	
	Date
Are you responsible for chemical safety in your laboratory? <input type="checkbox"/> No <input type="checkbox"/> Yes If Yes, take the Laboratory Safety Standard Compliance class.	
Do you work with hazardous chemicals? <input type="checkbox"/> No <input type="checkbox"/> Yes If Yes, take the online/classroom Managing Laboratory Chemicals class. REQUIRED	
Do you need to wear a respirator on the job? <input type="checkbox"/> No <input type="checkbox"/> Yes If Yes, follow the instructions at: http://www.ehs.washington.edu/ohsresp/index.shtm . REQUIRED	
Do you work with any form of recombinant DNA, pathogenic microorganisms, human / non-human primate tissues or other biohazardous agent? <input type="checkbox"/> No <input type="checkbox"/> Yes If Yes, take the Biosafety Training class. (Initial and every three years thereafter) REQUIRED	

UW Laboratory Employee Safety Training Checklist

Will you work in an Animal Biological Safety Level-3 or Biological Safety Level-3 Laboratory?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	If Yes, contact EH&S Research and Occupational Safety Office at 206.221.7770 additional training may be required. REQUIRED
Are you planning to work with Select Agents?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	If Yes, contact EH&S Research and Occupational Safety at 206.221.7770 additional training may be required. REQUIRED
Do you work with human cells, tissue or body fluids?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	If Yes, take the online/classroom Bloodborne Pathogens for Researchers class (Annual training) REQUIRED
Are you planning to use ionizing radiation?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	If Yes, follow the instructions at: http://www.ehs.washington.edu/rso/index.shtml . REQUIRED
Are you planning to use non-ionizing radiation?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	If Yes, contact EH&S Radiation Safety at 206.543.0463 additional training may be required. REQUIRED
Are you planning to use class 3b and 4 Lasers with a power greater than 5 milliwatts (mW)?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	If Yes, register for the Laser Safety Training at: http://www.ehs.washington.edu/forms/rso/laserreg.php . REQUIRED
Are you expected to use a fire extinguisher in the event of an emergency?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	If Yes, take the Fire Extinguisher Training class (Annual training) REQUIRED
Do you package, ship, and/or transport hazardous materials or infectious substances?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	If Yes, take the Shipping Hazardous Materials class or if applicable, the "Online Shipping Biological Substance Category B" or the "Online Shipping Dry Ice with non-dangerous goods or Exempt Patient Specimens" (initial and every two years thereafter) REQUIRED
Do you use a fume hood?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	If Yes, you should take the online Fume Hood class. (For more on fume hoods see http://www.ehs.washington.edu/fsofumehoods/index.shtml)
Do you handle cylinders containing hazardous, toxic, or flammable compressed gases?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	If Yes, you should take the Compressed Gas Safety class.
Are you expecting to work with Hydrofluoric Acid?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	If Yes, you should take the Hydrofluoric Acid Safety class.
Have you volunteered to be one of the First Aid and CPR staff for your lab?	
<input type="checkbox"/> No <input type="checkbox"/> Yes	If Yes, take the First Aid and CPR Certification class. (Initial and every two years thereafter) REQUIRED

Additional Specific Training

Use this section for any additional safety training needed in your laboratory due to "unusual hazards" such as forklift operation, confined space entry, maintaining powered equipment [lockout/tagout], working at heights [fall protection], lifting safety, or perchloric acid fume hood use.

After all of the training has been completed have the new employee sign and date this form and save it in your laboratory training records.

Employee Signature: _____ Date: _____



Appendix D - Example Standard Operating Procedures

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- B. BLANK STANDARD OPERATING PROCEDURE (SOP) FORM..... D-1

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- Figure D-1 Blank Standard Operating Procedure (SOP) Form D-2

A. EXAMPLE STANDARD OPERATING PROCEDURES (SOPs)

Current example SOPs are on-line at

<http://www.ehs.washington.edu/manuals/lsm/examplesoplincs.shtm>

Contact EH&S at uwcho@uw.edu or by telephone to 206-543-7388 concerning questions about SOPs, would like an SOP reviewed, or would like to have an SOP posted on the example SOP web page.

B. BLANK STANDARD OPERATING PROCEDURE (SOP) FORM

A copy of a “traditional” form used to record safety requirements is shown on the following page. An electronic copy of a blank form is available in Word format at

<http://www.ehs.washington.edu/manuals/lsm/sop.doc>.

Figure D-1 Blank Standard Operating Procedure (SOP) Form

University of Washington

Standard Operating Procedures for Chemicals or Processes		
#1 Process (if applicable)		
#2 Chemicals and Hazards		
#3 Personal Protective Equipment (PPE)		
#4 Environmental / Ventilation Controls		
#5 Special Handling Procedures & Storage Requirements		
#6 Spill and Accident Procedures		
#7 Waste Disposal		
#8 Special Precautions for Animal Use (if applicable)		
Particularly hazardous substance involved? (See Appendix H, Lab Safety Manual)	<input type="checkbox"/> YES:	Blocks #9 to #11 are Mandatory
	<input type="checkbox"/> NO:	Blocks #9 to #11 are Optional.
#9 Approval Required		
#10 Decontamination		
#11 Designated Area		
Name: _____ Title: _____		
Signature: _____ Date: _____		



Appendix E - Checklists

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A. EARTHQUAKE PREPARATION CHECKLIST FOR LABORATORY PERSONNEL

The following checklist is designed to help Department Chairs, Principal Investigators, and laboratory supervisors and personnel perform earthquake self-assessments. Use this list of questions to help identify situations that may pose a problem in an earthquake.

For free informational handouts on earthquake preparedness (including for home/family), call EH&S Training at 543-7201. Also check the Office of Emergency Management webpage for more earthquake preparedness information: <http://www.washington.edu/admin/business/oem/hazards/earthquake.html>

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're unfamiliar with your evacuation route(s), refer to your department's Emergency Evacuation and Operations Plan (EEOP) or contact your evacuation warden or evacuation director. For further information on evacuation routes from your building, contact EH&S at 206-543-0465.
 - 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 EEOP for location(s) of EAPs.
- Are gas cylinders well 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 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? Are exits and aisle ways maintained free and clear of obstructions?
- 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 how to operate them?
- Are chemical and biological spill kits available?
- Are extra food, water, flashlight, radios and batteries available?

Operations after a Major Earthquake

- After the shaking stops:
 - check for injured or physically limited people who might have trouble evacuating the building
 - turn off gas burners
 - 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 reenter the building until the building has been declared safe for entry by trained emergency personnel
- Depending on the time and 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 get back into your laboratory. Contact UW Office of Emergency Management 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 necessary tasks such as taking care of lab animals or making sure that 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?

Conclusion

Each of these items could be critical for the health and safety of laboratory occupants. While this checklist is directed toward earthquakes, building fires and other natural or man made disasters could have a similar impact on your laboratory and staff. We encourage you to discuss these plans and take whatever action is necessary to see that all items are addressed. Practice your disaster plans periodically to assure that the plans meet the requirements of current laboratory operations, that all staff are familiar with both the overall plan and their specific role, and that the plan is successful in accounting for staff and in reporting staff and laboratory conditions to key department administrators.

B. MOVING IN/NEW LABORATORY CHECKLIST

Use this checklist as a tool to help you get started with health and safety requirements. Refer to the Laboratory Safety Manual Section 10 - Moving In/Moving Out for more details.

General Safety

- If possible, visit the laboratory to determine if it will meet your needs, has been cleaned and is in good condition. If the lab had prior tenants, it should have a *Notice of Laboratory Moveout* (UoW 1800) 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.
- Reserve an accessible area for storage of health and safety related documents, including Material Safety Data Sheets/Safety Data Sheets (MSDSs/SDSs), training records and your Chemical Hygiene Plan (the UW Laboratory Safety Manual plus Laboratory-Specific Information.)
- Keep areas uncluttered, reserving three feet of space in all aisles.
- Do not block exits or safety equipment such as showers and eyewash stations.

Emergency Planning

- Know locations of emergency showers and eye washes.
- Know the emergency escape routes. Contact your Building Coordinator for more information.
- Prepare and post a floor plan which includes locations of signs, safety equipment, and process-related equipment. Show direction of exit from the laboratory.
- Post emergency phone numbers next to telephone.
- 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.

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 206-543-0465. To update fire extinguishers and safety showers, enter work order through local Facilities Services procedures (Refer to Appendix F, Lab Safety Manual for servicing Facilities Services.)
- To relocate or purchase a new biological safety cabinet (BSC), submit a Request to Purchase or Relocate a Biological Safety Cabinet Form to EH&S at <http://www.ehs.washington.edu/rbsbiosafe/approvedlist.shtm>
- Any new fume hoods and BSCs are required to be tested and certified by EH&S before research can start. Contact EH&S at 206-543-0465 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 lab does not have fire extinguisher, request one through your local Facilities Services. (Refer to Appendix F, Lab Safety Manual for servicing 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 servicing Facilities Services.)

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. (In Seattle, contact the Fire Marshal's Office Permit Section at 206-386-1450 to obtain the application form. If the lab is already covered under an existing SFD permit, contact permit holder with the department and arrange for SFD to conduct an inspection of the lab.) Contact EH&S at 206-543-0465 for technical assistance.

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 MSDSs/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 for hazardous materials
- Segregate and store your chemicals correctly. Refer to this manual and our 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 (training is available through EH&S) 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 206-543-0465 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, call EH&S at 206-616-5835.

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 online at <http://www.ehs.washington.edu/rbsresplan/bua.shtm>. This process also initiates the Institutional Biosafety Committee (IBC) approval process.

Additional requirements for animal research:

- Submit an Animal Use Medical Screening Form: <http://www.ehs.washington.edu/rbs/resocchealth.shtm>
- 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. See link: <http://www.ehs.washington.edu/rbsbiosafe/bsmanualindex.shtm>

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, annual training, and offering of hepatitis B vaccination. The UW core Exposure Control Plan is in the Biosafety Manual, at <http://www.ehs.washington.edu/rbsbiosafe/bsmanualindex.shtm>

- Complete the Supplemental Form for Bloodborne Pathogens to complete your site specific ECP, online at <http://www.ehs.washington.edu/forms/rbs/bbpecp.docx> .

For questions or assistance, contact EH&S at 206- 221-7770.

Radiation Safety

- New Principal Investigators:** 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 workers or a 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.)
- Using Lasers, non-ionizing radiation, EMF, RFR, etc requires that you contact RS for registration, surveys, and evaluation.

For questions or assistance, contact EH&S Radiation Safety at 206-543-0463.

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 Principal Investigators:** 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: <http://www.ehs.washington.edu/forms/epo/1471.pdf>. For more information about “routines”, see <http://www.ehs.washington.edu/epowaste/chemwaste.shtm>.

For questions or assistance call EH&S Environmental Programs at 206-616-5835.

EH&S Training

- Chemical Training
 - Managing Laboratory Chemicals: for staff working with chemicals
 - Laboratory Safety Standard Compliance: for PIs, Lab Managers and Supervisors to learn your responsibilities for health and safety of your employees.
 - MyChem training: optional for staff assigned to update chemical inventories and others who use MyChem
- Biological Safety Training
 - BSL-2/ABSL-2: for staff who work in BSL-2/ABSL-2 laboratories
 - Bloodborne Pathogens: for staff who work with bloodborne pathogens or other potentially infectious materials
- Radiation safety training for new workers
- Other EH&S courses that may apply to your work
 - Earthquake disaster preparedness
 - CPR certification
 - First Aid and CPR
 - Back Protection
 - Compressed Gas Safety
 - Fire extinguisher
 - Forklift Safety, Pallet Jack, and Narrow Aisle Lifters
 - Respiratory Protection and Fit testing
- Provide additional documented laboratory specific training as needed. PIs are responsible for providing additional documented laboratory specific safety training to staff.

For additional information about training, and to sign up for classes, see the EH&S training webpage at <http://www.ehs.washington.edu/psotrain/index.shtm>.

Office of Research - Research Required Training

- Check required training at: <http://www.washington.edu/research/compliance/required-training/> .

C. LABORATORY MOVING OUT CHECKLIST

Use this checklist as a tool to help you relocate or shut down your laboratory, or to temporarily relocate for remodels and renovations. Refer to the *Laboratory Safety Manual Section 10 - Moving In/Moving Out* for more details, including your responsibilities.

Laboratory Decontamination and Cleanout

- ❑ If you are partially or completely vacating your laboratory for remodeling, relocation or closure, you must leave it clean, empty and safe for Facilities Services staff or the next occupants. Follow all applicable instructions on the *Notice of Laboratory Moveout* (UoW 1800) online at <http://www.ehs.washington.edu/forms/fso/1800.pdf>. The Principal Investigator or laboratory manager/Chemical Hygiene Officer must sign the checklist to verify that all instructions were followed. **A copy of the *Notice for Laboratory Moveout* must be posted inside the door near one or more exits of your laboratory for Facilities Services or the next occupants.**

Chemical Safety

- ❑ Arrange for disposal of all hazardous waste and unwanted chemicals. (Attach a completed UW Hazardous Waste Label to any waste not in its original manufacturer's container, and complete and send a Chemical Collection Request form (UoW 1470) at least one month before you vacate.)
- ❑ Properly manage unwanted gas cylinders. (Return gas cylinders to the supplier or to whom you are leasing them from if at all possible. If you cannot do either, email chmwaste@u.washington.edu for assistance.)

For questions or assistance call EH&S Environmental Programs at 206-616-5835.

Biological Safety

- ❑ If your laboratory is relocating or shutting down, contact EH&S at 206-221-7770 to update your Biological Use Authorization Form and/or laboratory spaces.
- ❑ If you are relocating or ending research involving select agents, contact EH&S at 206-221-7770 for instructions.
- ❑ If you intend to relocate a biological safety cabinet, call 206-543-0465 or complete and submit a "Request to Purchase or Relocate a Biological Safety Cabinet" at <http://www.ehs.washington.edu/fsobiocab/approvedlist2.shtm>.
- ❑ If applicable, submit written plans for the decommissioning of a Biosafety Level 3 (BSL-3) area to EH&S (Box 357165).

For questions or assistance call EH&S at 206-221-7770.

Radiation Safety

- ❑ Notify EH&S in writing as soon as the intent to vacate is known. Mail correspondence to EH&S Radiation Safety, Box 354400 or e-mail radsaf@u.washington.edu. Inform Radiation Safety of your new laboratory location if known.
- ❑ Discuss arrangements with Radiation Safety to assure removal of all radioactive waste and to coordinate relocation or transfer of ownership for remaining radioactive materials (206-543-0463).

If the Principal Investigator is leaving the University of Washington, these additional steps must be followed with Radiation Safety:

- Usage records, including Radiation Survey Records, must be updated, finalized and submitted to Radiation Safety.
- Waste disposal records must be finalized and turned in to Radiation Safety.
- All radioactive material waste containers must be picked up by Radiation Safety.
- Personnel dosimeters must be returned to Radiation Safety.
- Termination bioassays must be performed if necessary.

For questions or assistance call EH&S Radiation Safety at 206-543-0463.

Transportation

- Biological Materials: follow the instructions in Appendix C of the UW Biosafety Manual, online at http://www.ehs.washington.edu/rbsbiosafe/BSM_AppC.pdf.
- Chemicals: follow the instructions in Section 10 Moving In/Moving Out and in Section 2 Chemical Management in your UW Laboratory Safety Manual. Under certain conditions, you can transport the chemicals yourself on campus. You can also arrange for a hazardous material contractor to pack and/or transport your chemicals for you.
- Radioactive Materials: For short moves of radioactive materials between locations on the contiguous UW Seattle campus, "hand carrying" is an option. For transport of radioactive materials over public roads, call Radiation Safety at 206-543-0463.
- Equipment and Non-Hazardous Items: you may choose to hire an outside moving company or UW Property & Transport Services to move equipment. Either way, do these two items first:
 - Schedule with your local Facilities Services to remove materials or equipment that are attached to the building or would impact building materials. Refer to the Laboratory Safety Manual, Appendix F, for contact means.
 - Decontaminate your laboratory equipment if it has or may have come into contact with hazardous materials. Follow the instructions and fill out Form UoW 1803 Notice of Laboratory Equipment Decontamination and attach it to the equipment. For more details, see the form at <http://www.ehs.washington.edu/forms/fso/lab equip.pdf>. To schedule pickup or drop off of surplus equipment, see <http://www.washington.edu/facilities/transportation/movingandsurplus>.
- Freezers: special arrangement must be made with EH&S to move freezers and Dewar flasks that contain infectious materials. Specialized moving companies can move other materials. See Section 10 of this manual for more details.

General

- Inform vendors and on-campus suppliers of your new box number and physical delivery address. Update your own information using your MyUW account. Follow guidelines on records retention in Section 7 of this manual and also on the Records Management website at <http://www.washington.edu/admin/recmgt/index.php>. Box and label sensitive files (data, patent files, etc.) for personal transport.

- ❑ If your laboratory is relocating, take your Laboratory Safety Manual and all laboratory-specific information (chemical inventory, standard operating procedures, training records, etc.) which will pertain to the new laboratory.
- ❑ If your laboratory is closing down permanently, give to your departmental administrator your copy of the Laboratory Safety Manual, a printout of your chemical inventory and your training records.
- ❑ If your laboratory is relocating or shutting down permanently, email mychem@u.washington.edu with your contact information to change your inventory location or eliminate your chemical inventory on MyChem.
- ❑ If you are leaving a leased or rented space, contact the UW Real Estate Office. Their website is at <http://www.washington.edu/admin/reo>.
- ❑ Notify your Building Coordinator that you are vacating your laboratory.
- ❑ Your department may have additional requirements for relocation and closure; check with your administrator.

D. UW LABORATORY INSPECTION CHECKLIST

The checklist at the website listed below is an example of the checklists currently being used to assess laboratories at the University of Washington.

<http://www.ehs.washington.edu/fsosurveys/prvaslbchklst.pdf> .

Explanatory information for each item on the checklist is available at:

<http://www.ehs.washington.edu/fsosurveys/checklistexpl.shtm> .



Appendix F - Resources for Laboratory Personnel

Contents

A. CALLING FOR ASSISTANCE F-1

B. WEB RESOURCES F-8

A. CALLING FOR ASSISTANCE

If you need more 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.

IN AN EMERGENCY: *DIAL 9 1 1*

Topic	Phone
<u>Accident/Incident Reports</u>	206.543.7388
<u>Air Pollution</u>	206.616.5835
<u>Animals (sick/injured)</u>	206.543.7209
<u>Asbestos Safety</u>	206.543.0469
Autoclave, Sharps and Biological Waste	206.221.7770
<u>Biological Safety Cabinets</u>	206.543.0469
Biological Safety	206.221.7770
<u>Bloodborne Pathogens Program</u>	206.221.7770
Bloodborne Pathogens Exposures	206.685.1026

Topic	Phone
Bothell Campus Info Line	425.352.3333
Alert System	See Link
Emergencies	9-1-1
Facilities Services Work Request Emergency phone number: 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) Station # 42, 10726 Beardslee Blvd. Bothell, WA 98011	425.486.1678
Building Evacuation Planning	206.543.0465
Building Repairs and Maintenance: See <i>Facilities Services</i>	See Listings
Calibrations for Radiation Detection Instruments	206.543.0463
Chemical Hazards (Worker Right-to-Know)	206.543.7388
Chemical Inventories	206.616.5835
Chemical Spills	206.616.5835
Confined Spaces	206.543.0465
Cranes and Hoists	206.543.0465
Diving Safety (Research)	206.221.7770
Dosimetry Services	206.543.0463
Drug Testing	206.543.7388
Earthquakes	206.543.0465
Electrical Safety	206.543.0465
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	206.543.0465
Seattle Campus, Campus Health Services	206.685.1026

Topic	Phone
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	206.543.7221
Electromagnetic Radiation	206.543.0463
Ergonomics	206.543.7388
Explosion	206.543.0465
Facilities Services:	<i>See Below</i>
Bothell Campus Work Request Emergency phone number: 425.352.5466	
Seattle Campus Emergency Repair	206.685.1411
Seattle Campus Information	<i>See Link</i>
Seattle Campus Central Zone	206.685.8814
Seattle Campus Health Sciences Zone	206.543.3010
Seattle Campus North East Zone	206.685.8815
Seattle Campus Outside Zone	206.616.5042
Seattle Campus South West Zone (includes Housing & Food Services)	206.543.5677
Tacoma Campus e-mail: facility@u.washington.edu Emergency phone number: 253.606.2908	253.692.5700
Fall Prevention	206.543.7388
Fire Safety	206.543.0465
Fire Safety Equipment Repair (Fire Extinguishers, etc.)	<i>See Below</i>
Bothell Campus Work Request Emergency phone number: 425.352.5466	
Seattle Campus	206.685.1411
Tacoma Campus	253.692.5700
Fire/Building Code Consultations	206.543.0465
Food Poisoning	206.543.7209
Food Service Area	206.543.7209
Forklift Safety	206.543.0465
Freezer Purchase	206.543.0465
Fume Hood Monitoring and Use	206.543.0465
Fume Hood Maintenance/Repair	<i>See Below</i>

Topic	Phone
Bothell Campus: Work Order Emergency phone number: 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 Emergency: 253.606.2908	253.692.5700
Gas Cylinder Leaks	206.616.5835
General Health and Safety Information	206.543.7388
Hall Health Primary Care Center	206.685.1011
Hazardous Materials Storage	206.543.0465
Hazardous Material	206.543.0465
Health/Safety Plans	206.543.7388
Hospital Health and Safety:	<i>See Below</i>
UW Medical Center	206.598.4645
Harborview Medical Center	206.731.8742
Hospital Radiation Safety	206.543.0463
Indoor Air Quality (Odors)	206.543.0465
Industrial Hygiene	206.543.7388
Industrial Insurance Claim (Worker's Compensation) – Risk Management	206.543.0183
Labor and Industry Inspections	206.543.7388
Laboratory Safety: General	206.543.7388
Lasers	206.543.0463
Lead Safety	206.543.0465
Lockout/Tag Out	206.543.0465
Medical Surveillance	206.221.7770
MyChem	206.616.4046
Material Safety Data Sheets (MSDSs) / Inventory	206.616.4046
Noise/Hearing Conservation	206.543.0465
Occupational Health Nurse (Medical surveillance)	206.221.7770
Occupational Health Nurse (Clinical/Consultation)	206.598.4848
Odors: Indoor Air Quality	206.543.0465

Topic	Phone
Personal Protective Equipment	206.543.7388
Pest Control	206.543.0465
Bothell Campus Work Request Emergency phone number: 425.352.5466	
Seattle Campus, Off-Campus	206.543.0465
Tacoma Campus Emergency: 253.606.2908	253.692.5700
Physical Plant: <i>See Facilities Services</i>	<i>See Listings</i>
Police / Security	<i>See Below</i>
Bothell Security and Campus Safety	425.352.5222
Harborview Medical Center Public Safety Emergencies Non-Emergency phone number:	206.744.5555 206.744.3193
Tacoma Campus Safety and Security Emergencies: 253.692.4888 E-mail: uwtsafe@u.washington.edu	253.692.4416 Or #333
UW Medical Center Public Safety	206.598.4909
UW Police Department Emergencies Non-Emergency phone number:	9-1-1 206.685.8973
Pressure Systems (vessels, cylinders, sterilizers, etc.)	206.543.0465
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	<i>See Below</i>
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 Emergencies: 253.692.4888 E-mail: uwtsafe@u.washington.edu	253.692.4416 Or #333
UW Medical Center	206.598.4645
Sanitation	206.543.0465
Scaffold	206.543.0465
Seattle Campus Info Line	206.897.4636
Seattle Fire Department (Administrative)	206.386.1400

Topic	Phone
Security: See Police / Security	<i>See Listings</i>
Sharps Disposal	206.221.7770
Shipping & Transporting	<i>See Below</i>
Biological/Infectious Waste	206.221.7770
Hazardous Materials	206.616.5835
Radioactive Materials	206.543.0463
Spills-Hazardous	<i>See Below</i>
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
Surveys, Radiation Safety	206.543.6328
Surveys, Safety	206.543.0465
Tacoma Campus	<i>See Below</i>
Alert	<i>See Link</i>
Campus Safety and Security Emergencies: 253.692.4888 E-mail: uwtsafe@u.washington.edu	253.692.4416 Or #333
Campus Safety Escort	#333
Facilities Services e-mail: facility@u.washington.edu Emergency phone number: 253.606.2908	253.692.5700
Worker's Compensation / Risk Management	253.692.5669
Tacoma Fire Department (Administration) 901 S. Fawcett Ave. Tacoma, WA 98402-5699	253.591.5737
Training	<i>See Below</i>
Health and Safety	206.543.7262
Radiation Safety	206.543.0463
Ultraviolet Light	206.543.0463
Waste Disposal – Hazardous	<i>See Below</i>

Topic	Phone
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 1.866.897.INFO
Water Quality	206.543.7209
Workplace Violence	See Below
Bothell Campus Emergency Response	9-1-1
Other Actions, See <i>Bothell Campus</i>	See Listings
Seattle Campus Human Resources: Upper Campus	206.685.1516
Seattle Campus Human Resources: Medical Centers, Health Sciences	206.731.3366
Tacoma Campus, Emergency Response	9-1-1
Other Actions, See <i>Tacoma Campus</i>	See Listing

B. WEB RESOURCES

Resource	Web Address
EH&S Offices	
Building and Fire Safety	www.ehs.washington.edu/fso/
Environmental Programs	www.ehs.washington.edu/epo/
Campus Health Services	http://www.ehs.washington.edu/chs/index.shtm
Radiation Safety	www.ehs.washington.edu/rso/
Research & Occupational Safety	www.ehs.washington.edu/rbs/
EH&S General Resources	
Accident Reporting	www.ehs.washington.edu/ohsoars/
Forms	www.ehs.washington.edu/forms/
MyChem	www.ehs.washington.edu/epomychem/
Posters (workplace)	www.ehs.washington.edu/manuals/
Research Planning	www.ehs.washington.edu/rbsresplan/
Respiratory Protection	http://www.ehs.washington.edu/ohsresp/index.shtm
Safety Committees	www.ehs.washington.edu/ohssafcom/
Training	www.ehs.washington.edu/psotrain/
Waste Management	www.ehs.washington.edu/epowaste/
EH&S Manuals/Plans	www.ehs.washington.edu/manuals/
Biosafety Manual	www.ehs.washington.edu/rbsbiosafe/bsmanualindex.shtm
Emergency Evacuation & Operations Plan	http://www.ehs.washington.edu/fsoemerprep/index.shtm
Lab Safety Manual	http://www.ehs.washington.edu/manuals/lsm/index.shtm
Radiation Safety Manual	www.ehs.washington.edu/manuals/rsmanual/
Other UW	
Facilities Services	www.washington.edu/admin/facserv/
UW Emergency Management	www.washington.edu/admin/business/oem/
Regulatory Agencies	
EPA	www.epa.gov
OSHA	www.osha.gov
WA Dept. of Ecology	www.ecy.wa.gov
WA Dept. of Labor & Indus	www.lni.wa.gov

Government Resources	
Centers for Disease Control and Prevention	www.cdc.gov
Department of Homeland Security	http://www.dhs.gov/index.shtm
Federal Emergency Management Agency (FEMA)	www.fema.gov
King County safety	http://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	http://emd.wa.gov
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
Howard Hughes Medical Institute	www.practicingsafescience.org



Appendix G - Gloves

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A. CHOOSING GLOVES

1. Primary Concern

The primary concern for gloves used to protect the skin from chemical contact is that they provide adequate worker safety. (This appendix only addresses chemical protective gloves and does not address protection from cuts, burns, electricity, etc.)

After ensuring that a glove provides adequate chemical protection, the gloves should be tested while performing the laboratory procedure, to ensure the glove provides enough dexterity that the work can be done. If a glove is too slippery to allow gripping the work, a different type glove can be worn over the chemical protective glove to improve dexterity.

Sometimes, workers do not want to wear effective gloves because they are not comfortable. A big factor frequently in worker comfort is that the right size glove is available. In other cases, worker comfort can be improved in some cases by wearing cotton inserts within the chemical protective glove or by purchasing gloves designed to be more comfortable.

2. Glove Weaknesses

Either degradation or permeation may affect gloving material.

a. Degradation

This is when glove material breaks down due to chemical contact. Exposed gloves may get harder, softer, expand, contract, stiffen, weaken or become brittle.

b. Permeation

This means leaking through the glove material even if the glove material is not susceptible to chemical attack. Permeation can occur even if there is no visible damage to the gloves being worn. Thicker gloves usually resist permeation better than thin gloves.

The information in Table G-3, Glove Guide for Specific Chemicals, is based primarily on permeation information for thick (20 mil) gloves.

B. GLOVE MATERIALS

Different gloving materials offer different kinds of protection. The following will help you understand the various glove-related terms used.

1. Natural Rubber

A naturally produced rubber (commonly called latex) that is highly elastic and flexible. This type material resists bases, acids, alcohols and diluted water solutions of most types of chemicals, especially when it is thick (18 mils or more). **Latex (natural rubber) exam gloves and thin latex gloves do not provide chemical protection.**

The primary concern from latex gloves is that the proteins in latex can produce allergic reactions in some people (as described later in Appendix G in Section C). Latex gloves are not alike. Powder-free gloves transfer less protein to the skin and respiratory tract. Hypoallergenic gloves have lower protein levels because of additional washing after manufacture. Because of these differences, there is over a 500-fold difference in protein levels between different style gloves from different manufacturers.

2. Neoprene

A synthetic rubber developed as an oil-resistant substitute for natural rubber. Neoprene has excellent resistance to all straight-chain hydrocarbons, all aliphatic hydroxy compounds such as methyl and ethyl alcohols and ethylene glycol, animal and vegetable fats and oils, and fluorinated hydrocarbons such as Freon refrigerants.

3. Nitrile

Nitrile is a synthetic rubber with chemical protection as well as superior puncture, cut, snag, and abrasion resistance. Nitrile is often available in thin and heavy gauges and offers excellent protection against alkaline solutions, saturated salt solutions and aliphatic hydrocarbons, both saturated and unsaturated. It is little affected by fatty acids found in vegetable fats and oils or by aliphatic alcohols, glycols, glycerols. Nitrile is not recommended for use in the presence of strong oxidizing agents, ketones, acetates, and a few other chemicals.

4. PVC

Polyvinyl chloride (PVC) or vinyl is a plastic material that resists amines, aromatics, inorganic acids, bases, and salts but not aldehydes, ketones, halogen compounds, and petroleum products.

5. Viton

A specialty fluoroelastomer which is the most chemical resistant of all rubbers. It protects against oils, fuels, and lubricants, most mineral acids, hydraulic fluids and aliphatic and aromatic hydrocarbons.

6. PVA

Polyvinyl Alcohol, PVA is a plastic material that protects against aromatics, ketones and chlorinated solvents. PVA coating is water soluble. **Do not use in water or water based solution.**

7. Butyl

Butyl rubber provides superior resistance to highly corrosive acids and is excellent against ketones and esters. It should not be worn with halogenated compounds.

8. Plastic Film

Special, multiple laminated layers of different type plastics make these gloves resistant and impervious to the vast majority of common chemicals. Examples are 4H and SilverShield gloves. These gloves have very poor dexterity and most workers wear latex gloves over the plastic film gloves to improve the dexterity.

C. LATEX ALLERGIC REACTIONS

Since 1988, allergies to natural rubber latex have become a serious concern to workers in frequent contact with latex derived products. For laboratory and health care personnel this chronic exposure comes from the frequent use of disposable latex gloves.

Glove related chemical sensitizers are found in both latex and synthetic gloves as residue from the glove manufacturing process. Powder, used to make the gloves easier to put on, absorbs these

chemicals and unbound latex proteins. The powder works as an abrasive, accelerating the individual's sensitivity to the chemicals/proteins it has absorbed. **Environmental Health and Safety (EH&S) Department recommends purchasing powder-free latex or synthetic gloves.**

Three types of reactions are associated with latex gloves: irritation, delayed hypersensitivity reaction, and immediate hypersensitivity reaction.

1. Irritation

All individuals are susceptible to irritation caused by direct cell injury. The abrasive nature of powder particles may initiate or aggravate irritating symptoms.

a. Symptoms

The first symptoms are redness with associated burning or itching. It appears where the glove is tighter on knuckles, the back of the hands or on the wrists.

b. Prevention

Wear larger gloves to reduce pressure areas and increase air circulation. Use powder free gloves. After removing gloves, wash your hands with mild soap and water and keep your hands conditioned with hand lotions and creams. Water-based lotions are more compatible with latex than oil-based lotions.

c. Reactions

People who are genetically predisposed to develop sensitivity to the powders, chemicals, and/or proteins found in the latex gloves can have either a delayed or immediate hypersensitivity reaction.

2. Delayed Hypersensitivity Reaction

a. Symptoms

The skin in the gloved area becomes red and painful with small blisters appearing. This reaction often spreads beyond the border of the glove. The skin reaction will recur and will be more severe with every exposure to latex.

b. Prevention

An option is to use a powder free synthetic rubber with less allergic potential such as vinyl, nitrile, or neoprene gloves. You should also see your health care provider for evaluation. A prescription strength steroid cream is often required to calm the allergic reaction.

It is important to know that people with this delayed skin sensitivity reaction do not go on to develop the Immediate Hypersensitivity Reaction.

3. Immediate Hypersensitivity Reaction

a. Symptoms

A very small exposure to latex can trigger an extreme reaction in some sensitized individuals. These people may have the reactions simply by being in a room with someone using powdered latex gloves. The symptoms include hives, itching all over,

nasal congestion, swelling of lips, eyelids, and face, shortness of breath, rapid heartbeat, abnormally low blood pressure, and shock.

b. Prevention

People with this reaction must avoid all products containing latex (balloons, condoms, dental dams, etc.). Wear a medic alert bracelet, showing an allergy to latex. Remember that the emergency responders will be wearing latex gloves.

c. First Aid

First Aid for individuals with immediate hypersensitivity reaction to latex - Carry an Epi Pen or Anakit for self-injection with epinephrine at the first sign of symptoms. Seek medical treatment immediately. These reactions can be medical emergencies.

D. GLOVE SIZES

Determine your proper size by using a tape measure to find the circumference of your hand around the palm. This measurement in inches is closest to your actual glove size. For example 7 inches is equal to a size 7 glove. Sizes may vary among styles and manufacturers. Most often gloves are sized according to men's hands.

Table G-1 Glove Sizes

	Extra Small (XS)	Small (S)	Medium (M)	Large (L)	Extra Large (XL)
Hand Size (Inches)	6-7	7-8	8-9	9-10	10-11

E. OFF-CAMPUS SOURCES FOR GLOVES

Table G-2 Glove Suppliers

	Natural rubber	Neo-prene	Nitrile	PVC	Viton	PVA	Butyl	4H	Silver Shield
<i>VWR Scientific Products</i> 1-800-932-5000 www.vwrsp.com	X	X	X	X	X	X	X		
<i>Lab Safety Supply</i> 1-800-356-0783 www.labsafety.com		X	X	X	X	X	X	X	X
<i>Best Mfg. Company</i> 1-800-241-0323	X	X	X	X	X		X		
<i>Ansell Edmont Industrial</i> 1-800-800-0444	X	X	X	X		X			
<i>Guardian Mfg. Company</i> 1-800-243-7379		X					X		

F. GLOVE SELECTION FOR SPECIFIC CHEMICALS CHART

The following chart is to be used only as a *general* guide to the type of glove to be worn as protection against accidental splashes and spills. Each glove manufacturer uses their own formulations to produce gloves. No two-glove manufacturers produce gloves exactly alike. Manufacturers will often make several types of glove from the same material, e.g., nitrile. Each of these gloves has specific uses specified by the manufacturer.

If your gloved hands will be immersed in a chemical or they will be in contact with a chemical for more than a few minutes, then contact a manufacturer. Manufacturers can send you glove guides/charts or provide recommendations. You can also contact EH&S, 206-543-7388, for recommendations on the best glove to use.

Latex exam gloves are not intended for use with chemicals.

The following chart was compiled using the glove guides provided by the manufacturers listed in the footnotes.

Table G-3 Glove Guide for Specific Chemicals

Chemical	Excellent	Very Good
Acetaldehyde ^{3&5}	Butyl ³ , 4H ⁵ , SilverShield ⁵	
Acetamide ¹	Butyl, Nitrile	
Acetic Acid, Anhydride ¹	Neoprene	Butyl
Acetic Acid, 30% ¹	Neoprene	
Acetic Acid, 50% ⁵	Nitrile, Neoprene	
Acetic Acid, 84% ⁴	Neoprene, Nitrile, Butyl, Viton	
Acetic Acid, Glacial ^{2&5}	Neoprene ² , 4H ⁵	Natural Rubber
Acetone ^{3&5}	Butyl ³ , 4H ⁵ , SilverShield ⁵	Neoprene ³
Acetonitrile ^{2,4&5}	Neoprene ² , Butyl ⁴ , 4H ⁵ , SilverShield ⁵	
Acetophenone ¹	Butyl	
Acrylic Acid ²	Natural Rubber	
Acetyl Chloride ¹	Viton	
Acetylene ¹	Butyl, PVC, Viton	
Acrylamide, 50% ⁴	Butyl, Viton, Neoprene, Nitrile	
Acrylonitrile ⁴	Butyl	Neoprene
Adipic Acid ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Alkazene ¹		Viton
Allyl Alcohol ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Alum-NH3-Cr-K ¹	Butyl, Nitrile, Neoprene	
Aluminum Acetate ¹	Viton, Butyl, PVC	
Aluminum Chloride ¹	Viton, Butyl, Nitrile, Neoprene	PVC
Aluminum Fluoride ¹	Viton, Butyl, Nitrile, Neoprene	PVC
Aluminum Hydroxide ¹	Viton, Nitrile, Neoprene	PVC, Butyl
Aluminum Nitrate ¹	Viton, Butyl, Nitrile, Neoprene, PVC	

Chemical	Excellent	Very Good
Aluminum Phosphate ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Aluminum Sulfate ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Ammonia, Anhydrous ⁴	Butyl, Viton, Nitrile	Neoprene
Ammonia ³	Butyl, Neoprene	
Ammonium Carbonate ¹	Viton, Butyl, Neoprene, PVC	
Ammonium Chloride ¹	Viton, Butyl, Nitrile, Neoprene	PVC
Ammonium Fluoride, 40% ²	Nitrile, Neoprene, PVC, Natural Rubber	
Ammonium Hydroxide, Conc. ²	Nitrile, Neoprene, PVC, Natural Rubber	
Ammonium Hydroxide ³	Butyl, Neoprene	
Ammonium Hydroxide, 29% ^{4&5}	Neoprene ⁴ , Butyl ⁴ , Viton ⁴ , 4H ⁵	
Ammonium Nitrate ¹	Viton, Butyl, Nitrile, PVC	Neoprene
Ammonium Persulfate ¹	Viton, Butyl, Neoprene, PVC	
Ammonium Phosphate ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Ammonium Salts ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Ammonium Sulfate ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Amyl Acetate ²	Nitrile ²	
Amyl Alcohol ⁴	Butyl, Nitrile, Neoprene, Natural Rubber	
Amyl Borate ¹	Viton, Nitrile, Neoprene	
Amyl Chloronapthalene ¹	Viton	
Aniline ^{3&5}	Butyl ³ , 4H ⁵ , SilverShield ⁵	Neoprene ³
Aniline Dyes ¹		Viton, Butyl, Neoprene
Aniline Hydrochloride ¹	PVC	Viton, Butyl, Nitrile
Ansul Ether ¹		Butyl
Aqua Regia ⁴	Natural Rubber, Butyl, Viton, Neoprene, Nitrile	
Arochlor(s) ¹	Viton	
Arsenic Acid ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Arsenic Trichloride ¹	Viton, Nitrile, Neoprene	PVC
Askarel ¹	Viton	PVC, Nitrile
Asphalt ¹	Viton	PVC, Nitrile
Barium Chloride ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Barium Hydroxide ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Barium Sulfide ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Battery Acid ⁴	Neoprene, Nitrile, Butyl, Viton	
Benzaldehyde ⁴	Butyl, Viton	
Benzene ^{3,4&5}	Butyl ³ , Natural Rubber ⁴ , Viton ⁴ , 4H ⁵ , SilverShield ⁵	
Benzoic Acid ¹	Viton	PVC
Benzyl Chloride ¹		
Benzyl Alcohol ¹	Viton	Butyl, Neoprene
Benzyl Benzoate ¹	Viton, PVC	Butyl
Benzyl Chloride ¹	Viton	
Beryllium ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Black Sulfur Liquor ¹	Viton, PVC	Butyl, Nitrile, Neoprene
Blast Furnace Gas ¹	Viton, PVC	

Chemical	Excellent	Very Good
Bleach Solutions ¹	Viton, Butyl, PVC	
Borax ¹	Viton, Butyl, Neoprene, PVC	Nitrile
Bordeaux Mixture ¹	Viton, Butyl, PVC	Nitrile, Neoprene
Boric Acid ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Boron Trifluoride ¹		PVC
Bromine ¹	Viton, PVC	
Bromoform ⁴	Viton	
Bromopropionic Acid ²	Natural Rubber	
1,3-Butadiene ⁴	Viton, Nitrile	Butyl
Butane ¹	Viton, Nitrile, Neoprene	PVC
Butoxypropanol ⁴	Neoprene, Nitrile, PVC, Butyl, Viton	Natural Rubber
Butoxytriglycol ⁴	PVC, Butyl, Viton, Neoprene, Nitrile	
Butyl Acetate ^{3&5}	4H ⁵ , SilverShield ⁵	Butyl ³
Butyl Acetyl Ricinoleate ¹	Viton, Butyl, PVC	Neoprene
Butyl Alcohol, Butanol ⁴	Viton, Butyl, Neoprene, Nitrile, Natural Rubber	PVC
Butyl Amine ⁴		Natural Rubber, Butyl, Viton
Butyl Benzoate ¹	Viton	Butyl, PVC
Butyl Carbitol Solvent ⁴	Neoprene, Nitrile, PVC, Viton, Butyl	
Butyl Cellosolve ^{2&4}	Nitrile ² , Neoprene ² , PVC ⁴	
Butyl Dipropasol Solvent ⁴	Neoprene, Nitrile, PVC, Butyl, Viton	
Butyl Ethylene	Viton, Nitrile	
Butyl Oleate ¹	Viton, PVC	Butyl
Butyl Propasol Solvent ⁴	Neoprene, Nitrile, PVC, Butyl, Viton	Natural Rubber
Butyl Stearate ¹	Viton	Viton, Butyl, Nitrile, PVC
p-tert-Butyl Toluene ^{3,4&5}	Butyl ³ , Nitrile ⁴ , PVC ⁴ , Viton ⁴ , 4H ⁵ , SilverShield ⁵	
γ-Butyrolactone ²	PVA, Natural Rubber	Neoprene
Butyraldehyde ¹		Butyl
Butyric Acid ¹	Viton, PVC	Butyl
Calcium Acetate ¹	Butyl, PVC	Nitrile, Neoprene
Calcium Bisulfite ¹	Viton, Nitrile, Neoprene, PVC	
Calcium Chloride ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Calcium Hydroxide ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Calcium Hypochlorite ¹	Viton, Butyl, PVC	
Calcium Nitrate ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Calcium Sulfide ¹	Viton, Butyl, Neoprene, PVC	
Carbamate ¹	Viton, PVC	Butyl, Neoprene
Carbinol ³	Butyl	
Carbitol ¹		Viton, Butyl, Nitrile, Neoprene, PVC
Carbolic Acid ⁴	Viton, Butyl	
Carbon Bisulfide ¹	Viton	
Carbon Dioxide ¹	Viton, Nitrile, PVC	Butyl, Neoprene
Carbon Disulfide ^{2,4&5}	PVA ² , Viton ⁴ , 4H ⁵ , SilverShield ⁵	
Carbonic Acid ¹	Viton, Butyl, Neoprene, PVC	Nitrile

Chemical	Excellent	Very Good
Carbon Monoxide ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Carbon Tetrachloride ^{2,4&5}	Viton ⁴ , PVA ² , Nitrile ⁴ , 4H ⁵ , SilverShield ⁵	
Caustic Soda 50% ⁴	Neoprene, Nitrile, PVC, Butyl, Viton	Natural Rubber
Cellosolve ¹		Butyl, Vinyl
Cellosolve Acetate ^{2&4}	Butyl ⁴	Natural Rubber ²
Cellosolve Solvent ²	Neoprene, Natural Rubber	
Cellulube ¹	Viton, Butyl	PVC
Chlorine (Dry) ¹	Viton	PVC
Chlorine (Wet) ³	Butyl	
Chlorine Dioxide ¹	Viton, PVC	
Chlorine Trifluoride ¹	Vinyl	
Chloroacetic Acid ¹	Viton, PVC	Butyl
Chloroacetone ¹		Butyl, Neoprene
Chlorobenzene ^{2&4}	Viton ⁴ , PVA ²	
Chlorobromomethane ¹		Butyl
Chlorobutadiene ¹	Viton	
Chlorododecane ¹	Viton	
Chloroform ^{2&5}	PVA ² , 4H ⁵	
Chloromethane ³	Butyl, Neoprene	
O-Chloronaphthalene ^{2&5}	SilverShield ⁵	PVA ²
1-Chloro 1-Nitro Ethane ¹		
Chlorox Solution ¹	Viton, Neoprene	Butyl, Nitrile, PVC
Chlorosulfonic Acid ¹	Vinyl	
Chlorothene ³	Butyl, Neoprene	
Chlorothene VG ²		PVA
Chlorotoluene ¹	Viton	PVC
Chrome Plating Solutions ¹	Viton, PVC	
Chromic Acid , 50% ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Chromium Trioxide ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Citric Acid ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Citric Acid, 10% ²	Nitrile, Neoprene, PVC, Natural Rubber	
Citric Acid, 30% ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Coal Tar Products ¹	Nitrile	
Cobalt Chloride ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Copper Acetate ¹	Viton, Butyl, PVC	Nitrile, Neoprene
Copper Chloride ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Copper Cyanide ¹	Viton, Butyl, Nitrile, Neoprene, PVC	
Copper Sulfate ¹	Viton, Nitrile, Neoprene, PVC	Butyl
Creosote ¹	Viton	Nitrile
Cresol ⁴	Neoprene, PVC, Butyl, Viton	Natural Rubber
Cresylic Acid ⁴	Neoprene, PVC, Butyl, Viton	Natural Rubber
Cumene ¹	Viton	PVC
Cyclohexane ⁵	Viton, Nitrile, Neoprene, Butyl, 4H	Silver Shield

Chemical	Excellent	Very Good
Cyclohexanol ^{4&5}	Neoprene ⁴ , Nitrile ⁴ , Natural Rubber ⁴ , PVC ⁴ , Butyl ⁴ , Viton ⁴ , 4H ⁵ , SilverShield ⁵	
Cyclohexanone ^{3&5}	Butyl ³ , 4H ⁵ , SilverShield ⁵	
P-Cymene ¹	Viton	
Decalin ¹	Viton	
Decane ¹	Viton	Nitrile, Neoprene
Denatured Alcohol ¹	Viton, Butyl, Nitrile, Neoprene	PVC
Developing Fluids ¹	Viton, PVC, Nitrile, Neoprene	Butyl
Diacetone Alcohol ⁴	Neoprene, Natural Rubber, PVC, Butyl, Viton	
Dibenzyl Ether ¹		Butyl
Dibenzyl Sebacate ¹		Viton, Butyl
Dibutyl Amine ¹		PVC, Nitrile, neoprene
Dibutyl Phthalate ^{1,2,3&5}	PVA ² , Butyl ³ , 4H ⁵ , SilverShield ⁵	
Dibutyl Sebacate ¹		Viton, Butyl
O-Dichlorobenzene ⁴	Viton	
Dichloromethane ³	Butyl	
1,2-Dichloroethane ⁵	Viton, 4H ⁵ , SilverShield ⁵	
Dichlorotrifluoroethane		Neoprene
Diesel Oil ⁴	Viton, Nitrile, PVC, Neoprene	
Diethanolamine ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Diethylamine ³	Butyl ³	
Diethyl Ether ¹		
Diethylene Glycol ¹	Viton, Butyl, Nitrile, Neoprene	PVC
Diethylene Glycol Monobutyl Ether ⁴	Natural Rubber, PVC, Butyl, Viton, Neoprene, Nitrile	
Diethylene Glycol Monohexyl Ether ⁴	Natural Rubber, PVC, Butyl, Viton, Neoprene, Nitrile	
Diethylene Glycol Monomethyl Ether ⁴	Natural Rubber, PVC, Butyl, Viton, Neoprene, Nitrile	
Diethylene Glycol Monopropyl Ether ⁴	Natural Rubber, PVC, Butyl, Viton, Neoprene, Nitrile	
Diethylene Oxide ⁴	Butyl	
Diethyl Sebacate ¹		Viton, Butyl
Diisobutylene ¹	Viton	Nitrile
Di-Isobutyl Ketone, DIBK ⁵	Silver Shield, Butyl, Nitrile, Viton, 4H	
Diisopropyl Benzene ¹	Viton	
Diisopropyl Ketone ¹	Butyl	
n,n-Dimethyl Acetamide, DMAC ²		Natural, Rubber
Dimethyl Aniline ¹		
Dimethyl Formamide, DMF ^{2,3&5}	Butyl ³ , Nitrile ³ , 4H ⁵ , SilverShield ⁵	Natural Rubber ²
Dimethyl Phthalate ¹		Viton, Butyl, PVC
Dimethyl Mercury	Silver Shield or 4H worn under long-cuffed, unsupported neoprene, nitrile or other heavy duty gloves ⁶	
Dimethyl Sulfoxide, DMSO ²	Nitrile, Neoprene, Natural Rubber	
2,6-Dimethyl-4-Heptanone ⁴	Nitrile, Neoprene, Natural Rubber, PVC, Butyl,	

Chemical	Excellent	Very Good
	Viton	
2,4-Dinitrotoluene, 40% in ROH ⁴	Butyl	Natural Rubber, Neoprene
Diocetyl Phthalate, DOP ^{1&2}		Viton ¹ , Butyl ¹ , PVA ²
Diocetyl Sebacate ¹		Viton, Butyl
1,4-Dioxane ^{3&5}	Butyl ³ , 4H ⁵ , SilverShield ⁵	
Dipropasol Glycol Monobutyl Ether ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Dipropylene Glycol Monopropyl Ether ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Divinyl Benzene ^{3,4&5}	Butyl ³ , Viton ⁴ , SilverShield ⁵	
Dowtherm Oil ¹	Viton	
Electroless Copper (MacDermid 9048) ²	Nitrile, Neoprene, PVC, Natural Rubber	
Electroless Nickel MacDermid J60/61) ²	Nitrile, Neoprene, PVC, Natural Rubber	
Epichlorohydrin ^{1 &2}	PVA ²	Butyl ¹
Ethanal ³	Butyl	
Ethane ¹	Viton, Nitrile	Neoprene, PVC
Ethanol ⁴	Neoprene, Nitrile, Natural Rubber, Butyl, Viton	PVC
Ethanolamine ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Ethanamine ³	Butyl	
2-Ethoxyethanol ⁴	Butyl, Viton	
Ethoxytriglycol ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Ethylamine, 70% in water ⁵	Silver Shield, Butyl	
Ethylene ¹	Viton, Nitrile, PVC	Butyl
Ethylene Chloride ¹	Viton	
Ethylene Chlorohydrin ¹	Viton	Butyl, Neoprene
Ethylene Diamine ¹	Butyl, Nitrile, Neoprene	PVC
Ethylene Dichloride ^{1&2}	Viton ¹ , PVA ²	
Ethylene Glycol ²	PVC, Nitrile, Neoprene, Natural Rubber	
Ethylene Glycol Ether ⁴	Butyl	
Ethylene Glycol Monobutyl Ether	Neoprene, Nitrile, PVC, Butyl, Viton	Natural Rubber
Ethylene Glycol Monohexyl Ether	Neoprene, Nitrile, PVC, Butyl, Viton, Natural Rubber	
Ethylene Glycol Monopropyl Ether	Viton, Neoprene, Nitrile	Butyl
Ethylene Oxide ³	Butyl, Neoprene	
Ethylene Trichloride ¹	Viton	
n-Ethylethaneamine ³	Butyl, Neoprene	
Ethyl Acetate ^{3&5}	Butyl ³ , Neoprene ³ , 4H ⁵ , SilverShield ⁵	
Ethyl Acetoacetate ¹	PVC	Butyl
Ethyl Acrylate ¹		Butyl
Ethyl Alcohol ^{1,2&5}	Viton ¹ , Butyl ¹ , Nitrile ² , Neoprene ² , 4H ⁵	PVC ¹
Ethyl Aldehyde ³	Butyl	
Ethyl Benzene ³	Butyl	
Ethyl Benzoate ¹	Viton	Butyl

Chemical	Excellent	Very Good
Ethyl Bromide ¹		Nitrile
Ethyl Butanol ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Ethyl Chloride ¹	Viton, Butyl, Nitrile	Neoprene
Ethyl Ether ^{2&5}	Nitrile ² , SilverShield ⁵	
Ethyl Formate ¹	Viton	Butyl, Neoprene, PVC
Ethyl Glycol Ether ²	Neoprene	Natural Rubber
Ethyl Mercaptan ¹	Viton	PVC
Ethyl Oxalate ¹	Viton, Butyl	PVC
Ethyl Silicate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Fatty Acids	Viton, PVC	Nitrile, Neoprene
Ferric Chloride	Viton, Butyl, PVC, Nitrile, Neoprene	
Ferric Nitrate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Ferric Sulfate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Fluohydric Acid ³	Butyl	
Fluoroboric Acid ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Fluorine (Liquid) ¹		Viton
Fluorocarbon Oils ¹	Butyl, Nitrile, PVC	Viton, Neoprene
Fluorolube ¹	Butyl, PVC, Nitrile, Neoprene	Viton
Fluorosilicic Acid ¹	Nitrile, Neoprene	Viton, Butyl
Formaldehyde, 37% ^{2&5}	Viton ⁵ , Butyl ⁵ , PVC ⁵ , Nitrile ² , 4H ⁵	Silver Shield ⁵
Formic Acid 90% ²	Neoprene, PVC, Natural Rubber	
Freon 11 ¹	Viton	Nitrile
Freon 12 ¹	PVC, Nitrile, Neoprene	Viton, Butyl
Freon 13 ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Freon 21 ¹	Nitrile	
Freon 22 ¹	Butyl, PVC, Neoprene	
Freon 31 ¹	Butyl, Neoprene	
Freon 32 ¹	Butyl, Nitrile, Neoprene	
Freon 112 ¹	Viton	Nitrile
Freon 113 ⁴	Butyl, Nitrile, Neoprene	
Freon 114 ¹	Butyl, Nitrile, Neoprene	Viton, PVC
Freon 115 ¹	Butyl, Nitrile, Neoprene	Viton, PVC
Freon 142B ¹	Butyl, Nitrile, Neoprene	
Freon 152A ¹	Butyl, Nitrile, Neoprene	
Freon 218 ¹	Viton, Butyl, Nitrile, Neoprene	PVC
Freon C316 ¹	Viton, Butyl, Nitrile, Neoprene	PVC
Freon C318 ¹	Viton, Butyl, Nitrile, Neoprene	PVC
Freon 114B2 ¹		Viton, Nitrile, neoprene
Freon 502 ¹	Butyl, Neoprene	Viton, Nitrile
Freon TA ¹	Butyl, Nitrile, Neoprene	Viton, PVC
Freon TC ¹	Butyl, Nitrile, Neoprene	Viton, PVC
Freon TF ^{1&2}	Viton ¹ , Nitrile ² , Neoprene ²	
Freon TMC ¹	Viton	Butyl, Nitrile, Neoprene

Chemical	Excellent	Very Good
Freon T-P35 ¹	Viton, Butyl, Nitrile, Neoprene	PVC
Freon T-WD602 ¹	Viton, Butyl	PVC, Nitrile, Neoprene
Freon BF ¹		Nitrile, Neoprene
Freon MF ¹	Nitrile	
Fuel Oil ¹	Viton, Nitrile	PVC, Neoprene
Fumaric Acid ¹	Viton, PVC, Nitrile	Neoprene
Furan ¹	PVC	
Furfural ⁴	Natural Rubber, Butyl	Neoprene
Gallic Acid ¹	Viton	Butyl, PVC, Nitrile, Neoprene
Gasoline, Unleaded ⁴	Viton, Nitrile	
Gasoline (White) ²	Nitrile	
Glucose ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Glutaraldehyde, 50% ⁴	Neoprene, Nitrile, Natural Rubber, Butyl, Viton	PVC
Glycerine ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Glycols ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Glyphosate Roundup(TM)	Butyl, Viton, Nitrile	
Green Sulfate Liquor ¹	Viton, Butyl, PVC	Nitrile, Neoprene
Halowax Oil ¹	Viton, PVC	
Heptane ⁴	Neoprene, Nitrile, Viton	
N-Hexaldehyde ¹	Neoprene	Butyl
Hexamethyldisilazane ²	Nitrile, Neoprene	
n-Hexane ⁵	Viton, Silver Shield, 4H, PVA, Nitrile	
n-Hexene ⁴	Viton, Nitrile	
Hexyl Carbitol Solvent ⁴	Neoprene, Nitrile, Natural rubber, PVC, Butyl, Viton	
Hexyl Cellosolve Solvent ⁴	Neoprene, Nitrile, Natural rubber, PVC, Butyl, Viton	
Hexyl Alcohol ¹	Viton, Nitrile	PVC, Neoprene
Hexylene Glycol ¹	Viton, Butyl	PVC, Nitrile, Neoprene
Hydraulic Oil ¹	Viton, Nitrile	Neoprene
Hydrazine Hydrate, 85% ⁴	Neoprene, Nitrile, Natural rubber, PVC, Butyl, Viton	
Hydrazine, 70% ⁵	Silver Shield, 4H, Butyl, Neoprene, PVC, Nitrile	
Hydrazine 65% ²	Nitrile, Neoprene, PVC, Natural Rubber	
Hydrobromic Acid ¹	Viton, Butyl, PVC	Neoprene
Hydrochloric Acid, Conc. ²	Nitrile, Neoprene, PVC, Natural Rubber	
Hydrochloric Acid, 10% ⁴	Nitrile, Neoprene, PVC, Natural Rubber, Viton, Butyl	
Hydrochloric Acid 37% ^{2&5}	Viton ² , PVC ² , Butyl ² , 4H ⁵ , SilverShield ⁵	Nitrile ² , Neoprene ²
Hydrocyanic Acid ¹	Viton, Butyl	PVC, Nitrile, Neoprene
Hydrofluoric Acid, 48% ^{4&5}	Butyl ⁴ , Neoprene ⁴ , 4H ⁵ , SilverShield ⁵	Nitrile ⁴ , Viton ⁴ , PVC ⁴
Hydrogen Chloride (gas) ³	Butyl, Neoprene	
Hydrogen Fluoride ⁴	Butyl	Neoprene, Natural

Chemical	Excellent	Very Good
		Rubber
Hydrogen Peroxide (90%) ¹	PVC	Viton
Hydrogen Peroxide (30%) ²	Nitrile, PVC, Natural Rubber	
Hydrogen Sulfide ¹	Butyl, PVC, Neoprene	
Hydroquinone ²	Nitrile, Neoprene, PVC	
Hydroquinone, Saturated	Nitrile, Neoprene, PVC	
Iodine ¹	Viton, PVC	Butyl, Nitrile
Iodomethane ⁴	Viton,	
Isoamyl Acetate ⁴		Nitrile
Isoamyl Alcohol ⁴	Natural Rubber, Butyl, Viton, Neoprene, Nitrile	PVC
Isobutyl Alcohol, Isobutanol ⁴	Viton, Butyl, Neoprene, Nitrile, Natural Rubber	PVC
Isooctane ²	Neoprene, Nitrile, PVA	
Isophorone ¹	Butyl	
Isopropyl Acetate ¹		Butyl
Isopropyl Alcohol, Isopropanol ⁴	Nitrile, Neoprene, Butyl, Viton, Natural Rubber	
Isopropyl Chloride ¹	Viton, PVC	
Isopropyl Ether ¹	PVC	Nitrile
JP3 ¹	Viton, Nitrile	
JP4 ¹	Viton, Nitrile	
Kerosene ^{2&4}	Nitrile ⁴ , Neoprene ⁴ , PVC ⁴ , Viton ⁴	PVA ²
Lactic Acid ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Lauric Acid, 36%/ EtOH ²	Nitrile, Neoprene, Natural Rubber	
Lead Acetate ¹	Viton, Butyl, PVC	Nitrile, Neoprene
Lead Nitrate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Lead Sulfamate ¹	Viton, Butyl, PVC, Neoprene	Nitrile
Lime Bleach ¹	Viton, Butyl, PVC, Nitrile	Neoprene
Lime Sulfur ¹	Viton, Butyl, PVC, Neoprene	
dl-Limonene ⁴	Nitrile, Viton	Neoprene, PVC
Lindol ¹	Butyl	Viton
Linoleic Acid ¹	PVC	Viton, Nitrile
Linseed Oil ¹	Viton, Nitrile	PVC, Neoprene
Liquified Petroleum Gas ¹	Viton, PVC, Nitrile	Neoprene
Lubricating Oils ¹	Viton, Nitrile	PVC, Neoprene
Lye ¹	Buytl, PVC	Viton, Nitrile, Neoprene
Magnesium Chloride ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Magnesium Hydroxide ¹	Viton, Butyl, PVC, Neoprene	Nitrile
Magnesium Sulfate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Malathion ¹		PVC, Nitrile, Neoprene
Maleic Acid ¹	Nitrile, Neoprene, Natural Rubber	
Maleic Anhydride ¹	Viton, PVC	
Mercuric Chloride ¹	Viton, Butyl, Nitrile, Neoprene	
Mercury ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Mesityl Oxide ¹		Butyl

Chemical	Excellent	Very Good
Methane ¹	Viton, PVC, Nitrile	Neoprene
Methoxytriglycol ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Methyl Acetate ²	Neoprene	Nitrile, Natural Rubber
Methyl Alcohol, Methanol ^{1&3}	Butyl ³ , PVC ¹ , Nitrile ¹ , Neoprene ³	
Methylamine ²	PVC, Natural Rubber, Nitrile	
Methyl Acrylate ¹		Butyl, Neoprene
Methylacrylic Acid ¹		Viton, Butyl, PVC, Neoprene
Methyl Bromide ^{1&2}	Viton ¹	PVA ² , Nitrile ¹
Methyl Butyl Ketone ¹	Butyl	
Methyl Carbitol Solvent ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Methyl Cellosolve ⁴	Neoprene, Natural Rubber, PVC, Butyl, Viton	
Methyl Chloride ^{2&4}	Viton ⁴ , Neoprene ⁴ , Nitrile ⁴ , PVC ⁴ , Butyl ⁴	PVA ² , Natural Rubber ⁴
Methylchloroform ³	Butyl, Neoprene	
Methylene Chloride ⁵	Silver Shield, 4H, PVA	
Methyl Ethyl Ketone, MEK ^{3&5}	Butyl ³ , Silver Shield ⁵ , 4H ⁵	
Methyl Formate ¹		Butyl, PVC, Neoprene
Methyl Iodide ⁴	Viton	
Methyl Isobutyl Ketone, MIBK ³	Butyl	
Methyl Methacrylate ²		PVA
Methyl Oleate ¹	Viton, PVC	Butyl
Methyl Propasol Solvent ⁴	Natural Rubber, Butyl, Neoprene, Nitrile	
N-Methyl-2-Pyrrolidone, NMP ^{2&4}	Natural Rubber ² , Neoprene ⁴ , Butyl ⁴	
Methyl Salicylate ¹	Butyl	
Methyl t-Butyl Ether, MTBE ²	Nitrile	PVA
Mineral Oil ¹	Viton, PVC, Nitrile	Neoprene
Mineral Spirits ⁴	Neoprene, Nitrile, Viton	PVC
Mineral Spirits, Rule 66 ²	Nitrile, PVA	
Monochlorobenzene ¹	Viton	
Monoethanolamine ²	Nitrile, Neoprene, PVC, Natural Rubber	
Monomethyl Ether ¹	Butyl, Nitrile, Neoprene	Viton, PVC
Monovinyl Acetylene ¹	Viton, Butyl, Nitrile	Neoprene
Morpholine ⁵	Butyl, Neoprene, Silver shield, 4H	PVA
Muriatic Acid ²	Nitrile, Neoprene, PVC, Natural Rubber	
Naphtha VM&P ²	Nitrile, PVA	Neoprene
Naphthalene ¹	Viton	
Neville Acid ¹	Viton, PVC	Butyl
Nickel Acetate ¹	Butyl, PVC	Nitrile, Neoprene
Nickel Chloride ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Nickel Sulfate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Nitric Acid, 10% ²	Nitrile, Neoprene	PVC, Natural Rubber
Nitric Acid, 23% ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	

Chemical	Excellent	Very Good
Nitric Acid, 70% ²		Neoprene
Nitric Acid, conc. ³	Butyl	
Nitric Acid-Dilute ¹	Viton, Neoprene	Butyl, PVC
Nitrobenzene ^{2,3&5}	Butyl ³ , Neoprene ³ , 4H ⁵ , SilverShield ⁵	PVA ²
Nitroethane ¹		Butyl
Nitromethane ²	Neoprene,	PVA
2-Nitropropane ^{2,3&5}	PVA ² , Butyl ³ , 4H ⁵ , SilverShield ⁵	Neoprene ²
Octadecane ¹	Viton, Nitrile	Neoprene
N-Octane ¹	Viton, Nitrile	Neoprene
Octachlorotoluene ¹	Viton	
Octyl Alcohol, n-Octanol ^{2&4}	Nitrile ² , Neoprene ² , Natural Rubber ⁴ , PVC ⁴ , Butyl ⁴ , Viton ⁴	PVA ²
Oleic Acid ²	Nitrile, Neoprene	PVA
Oleum Spirits ^{1&3}	Viton ¹ , PVC ¹ , Butyl ³ , Neoprene ³	Nitrile ¹
Oxalic Acid ²	PVC, Nitrile, Neoprene, Natural Rubber	
Palmitic Acid ²	Neoprene	PVC
PCBs 50% (Aroclor 1254/TCB) ⁴	Nitrile, Butyl, Viton	PVC
Pentachlorophenol ³	Neoprene	
n-Pentane ⁵	Viton, Silver Shield, 4H, Nitrile	
Perchloric Acid, 60% ²	Nitrile, Neoprene, PVC	
Perchloroethylene ²	PVA	Nitrile
Pentane ³	Neoprene	
Pentachlorophenol, 1% in Kerosene ⁵	Viton, Silver Shield, Neoprene, PVC, Nitrile	
Petroleum Ether ⁴	Nitrile, Viton	Neoprene
Phenol ^{2&5}	Neoprene ² , Natural Rubber ² , 4H ⁵ , SilverShield ⁵	PVC ²
Phenyl Benzene ¹	Viton	PVC
Phenyl Ethyl Ether ¹		Viton, PVC
Phorone ¹		Butyl
Phosphoric Acid, Conc. ²	Nitrile, Neoprene	PVC
Phosphoric Acid (20%) ¹	Viton, PVC	Butyl, Nitrile, Neoprene
Phosphoric Acid (45%) ¹	Viton, PVC	Butyl, Neoprene
Phosphoric Acid (85%) ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Phosphorous Trichloride ¹	Viton, Butyl, PVC	
Phthalic Acid Dibutyl Ester ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Picric Acid ¹	Viton, PVC, Neoprene	Butyl, Nitrile
Picric Acid, Sat. /EtOH ²	Nitrile, Neoprene, PVC	
Pinene ¹	Viton	PVC, Nitrile
Pine Oil ¹	Viton	PVC, Nitrile
Piperidene ¹		
Polyvinyl Acetate Emulsion ¹	Viton, Butyl, PVC, Nitrile	Neoprene
Potash 45% ⁴	Neoprene, Nitrile, PVC, Butyl, Viton	Natural Rubber
Potassium Acetate ¹	Butyl, PVC	Nitrile, Neoprene
Potassium Chloride ¹	Viton, Butyl, PVC, Nitrile, Neoprene	

Chemical	Excellent	Very Good
Potassium Cupro Cyanide ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Potassium Cyanide ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Potassium Dichromate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Potassium Hydroxide ³	Butyl, Neoprene	
Potassium Hydroxide, KOH, 45% ⁴	Neoprene, Nitrile, Natural Rubber, Butyl, Viton, PVC	
Potassium Hydroxide, 50% ²	Nitrile, Neoprene, PVC, Natural Rubber	
Potassium Nitrate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Potassium Sulfate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
2-Propanol ⁴	Viton, Butyl, Nitrile, Neoprene, Natural Rubber	
Propetamphos 50% in ROH ⁴	Neoprene, Nitrile, Natural Rubber, Butyl, PVC, Viton	
Propoxy Diethylene Glycol ⁴	Neoprene, Nitrile, Natural Rubber, Butyl, PVC, Viton	
Propoxypropanol ⁴	Neoprene, Nitrile, Natural Rubber, Butyl, Viton	
Propyl Acetate ^{2&3}	Butyl ³ , Neoprene ³	PVA ²
N-Propyl Acetate ^{1&5}	Butyl ³ , 4H ⁵ , SilverShield ⁵	PVC
Propyl Acetone ¹	Butyl	PVC
n-Propyl Alcohol, Propanol ⁴	Viton, Butyl, Nitrile, Neoprene	PVC
Propyl Carbitol Solvent ⁴	Neoprene, Nitrile, Natural Rubber, Butyl, Viton	
n-Propyl Cellosolve ⁴	Neoprene, Nitrile, Viton	Butyl
Propyl Cellosolve Solvent ⁴	Neoprene, Nitrile, Viton	Butyl
Propyl Dipropasol Solvent ⁴	Neoprene, Nitrile, Natural Rubber, Butyl, Viton, PVC	
Propyl Nitrate ¹		Butyl
Propylene ¹	Viton, PVC	
Propylene Glycol Monobutyl Ether ⁴	Neoprene, Nitrile, PVC, Butyl, Viton	Natural Rubber
Propylene Glycol Monomethyl Ether ⁴	Neoprene, Nitrile, Natural Rubber, Butyl, Viton	
Propylene Glycol Monopropyl Ether ⁴	Neoprene, Nitrile, Natural Rubber, Butyl, Viton	
Propylene Oxide ²		Butyl, PVA
Propyl Propasol Solvent ⁴	Neoprene, Nitrile, Natural Rubber, Butyl, Viton	
Pyranol ¹	Viton, Nitrile	
Pyridine ²		Butyl, PVA
Red Oil ¹	Viton, Nitrile	PVC, Neoprene
Rubber Solvent ²	Nitrile, PVA	Neoprene
Safrotin 50% in ROH ⁴	Neoprene, Nitrile, Natural Rubber, Butyl, Viton, PVC	
Sal Ammoniac ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Salicylic Acid ¹	Viton, Butyl, PVC, Neoprene	Nitrile
Silicate Esters ¹	Viton, Neoprene	Nitrile
Silicone Greases ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Silicone Oils ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Silver Nitrate ¹	Viton, Butyl, PVC, Neoprene	Nitrile
Skydrol 500 ¹		Butyl
Skydrol 7000 ¹	Butyl	Viton
Soda Ash ¹	Viton, Butyl, PVC, Nitrile, Neoprene	

Chemical	Excellent	Very Good
Sodium Bicarbonate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Sodium Acetate ¹	Butyl, PVC	Nitrile, Neoprene
Sodium Bisulfite ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Sodium Borate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Sodium Carbonate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Sodium Chloride ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Sodium Cyanide ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Sodium Hydroxide ³	Butyl, Neoprene	
Sodium Hydroxide, 50% ^{2&5}	Nitrile ² , Neoprene ² , Natural Rubber ² , 4H ⁵ , SilverShield ⁵	PVC ²
Sodium Hypochlorite 4-6% ⁴	Neoprene, Nitrile, Natural Rubber, PVC, Butyl, Viton	
Sodium Metaphosphate ¹	Viton, Butyl, PVC, Nitrile	Neoprene
Sodium Nitrate ¹	Viton, Butyl, PVC	Nitrile, Neoprene
Sodium Perborate ¹	Viton, Butyl, PVC	Nitrile, Neoprene
Sodium Peroxide ¹	Viton, Butyl, PVC	Nitrile, Neoprene
Sodium Phosphate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Sodium Silicate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Sodium Sulfate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Sodium Sulfide ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Sodium Sulfite ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Sodium Thiosulfate ¹	Viton, Butyl, PVC, Neoprene	Nitrile
Stannic Chloride	Viton, PVC, Nitrile, Neoprene	
Stearic Acid ¹	Viton, PVC	Butyl, Nitrile, Neoprene
Stoddard Solvent ²	Nitrile, Neoprene, PVA	
Styrene ^{2&4}	Viton ⁴	PVA
Sulfite Liquors ¹	Viton, PVC	Butyl, Nitrile, Neoprene
Sulfur ¹	Viton, Butyl, PVC, Neoprene	
Sulfur Chloride ¹	Viton, PVC	
Sulfur Dioxide ¹	Viton, PVC	Butyl
Sulfur Hexafluoride ¹	Viton, Butyl, PVC, Neoprene	Nitrile
Sulfur Trioxide ¹	Viton, PVC	Butyl
Sulfuric Acid (20% Oleum) ¹	Viton, PVC	
Sulfuric Acid 47% (battery acid) ²	Neoprene, Natural Rubber	PVC
Sulfuric Acid, 25% ⁵	Silver Shield, 4H, Butyl, Neoprene, Nitrile	
Sulfuric Acid, Fuming ³	Butyl, Neoprene	
Sulfuric Acid, Conc ³	Butyl, Neoprene	
Sulfurous Acid ¹	Viton	Butyl, PVC, Nitrile, Neoprene
Tannic Acid ²	PVC, Nitrile, Neoprene, Natural Rubber	
Tar, Bituminous ¹	Viton, PVC	Nitrile
Tartaric Acid ¹	Viton, PVC, Nitrile	Butyl, Neoprene
Terpineol ¹	Viton, PVC	Nitrile
Tertiary Butyl Alcohol ¹	Viton	Butyl, PVC, Nitrile,

Chemical	Excellent	Very Good
		Neoprene
Tertiary Butyl Catechol ¹	Viton, PVC	Butyl, Neoprene
Tertiary Butyl Mercaptan ¹	Viton	PVC
Tetrabromamethane ¹	Viton	
Tetrabutyl Titanate ¹	Viton, PVC	Butyl, Nitrile, Neoprene
Tetrachloroethylene ^{2&5}	PVA ² , 4H ⁵ , SilverShield ⁵	Nitrile ²
Tetrahydrofuran, THF ³	Butyl	
Tetralin ¹	Viton	PVC
Thionyl Chloride ¹	Viton, PVC	
Titanium Tetrachloride ¹	Viton, PVC	
Toluene, Toluol ^{2,3&5}	Butyl ³ , 4H ⁵ , SilverShield ⁵	PVA ²
Toluene Diisocyanate, TDI ^{3&5}	Butyl ³ , 4H ⁵ , SilverShield ⁵	
o-Toluidine ⁴	Butyl, Viton	Natural Rubber, Neoprene
Transformer Oil ¹	Viton, Nitrile	Neoprene
Transmission Fluid A ¹	Viton, Nitrile	Neoprene
Triacetin ¹	Butyl, PVC	Nitrile, Neoprene
Tributoxy Ethyl Phosphate ¹	Viton, Butyl	
Tributyl Phosphate ¹	Butyl	
Tributyl Mercaptan ¹	Viton	
Trichloroacetic Acid ¹	PVC	Butyl, Nitrile
1,2,4-Trichlorobenzene ⁴	PVC, Viton	
1,1,1-Trichloroethane ⁵	Viton, Silver Shield, 4H, PVA	
Trichloroethylene, TCE ^{2&5}	PVA ² , 4H ⁵	
Trichlorotrifluoroethane ⁴	Neoprene, Nitrile, Butyl, Viton	
Tricresyl Phosphate, TCP ²	Nitrile, Natural Rubber	PVA
Triethanolamine 85%, TEA ²	Neoprene, Nitrile, PVC	PVA, Natural Rubber
Triethyl Aluminum ¹	PVC	Viton
Triethyl Borane ¹	Viton, PVC	
Trinitrotoluene ¹		Viton, Neoprene
Trioctyl Phosphate ¹	Butyl	Viton
Triaryl Phosphate ¹	Viton, Butyl	
Tung Oil ¹	Viton, Nitrile	Neoprene
Turbine Oil ¹	Viton	Nitrile
Turpentine ²	Nitrile	PVA
Urea ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
UDMH ¹	Butyl	Nitrile, Neoprene
Varnish ¹	Viton	Nitrile
Versilube ¹	Viton, Butyl, Nitrile, Neoprene	
Vinyl Acetate ¹	Viton, Nitrile, Neoprene	
Vinyl Chloride ⁵	Viton, Silver Shield, Nitrile	
Vinyl Ethylene ³	Butyl, Neoprene	
Vinyl Styrene ⁴	Viton	
Wagner 21B Fluid ¹		Butyl, Neoprene

Chemical	Excellent	Very Good
White Pine Oil ¹	Viton	Nitrile
White Oil ¹	Viton, Nitrile	PVC, Neoprene
Xylene, Xylo ⁵	Viton, Silver Shield, 4H, PVA, Nitrile	
Zeolites ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Zinc Acetate ¹	Butyl, PVC	Nitrile, Neoprene
Zinc Chloride ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Zinc Oxide ¹	Viton, Butyl, PVC, Nitrile, Neoprene	
Zinc Sulfate ¹	Viton, Butyl, PVC, Nitrile, Neoprene	

- 1 ILC Dover, a division of ILC Industries, P. O. Box 266, Frederica, DE 19946, #302-335-3911
- 2 Ansell Edmont Industrial, 1300 Walnut Street, P.O. Box 6000, Coshocton, OH 43812, #800-800-0444
- 3 Guardian Manufacturing Company, 302 Conwell Avenue, Willard, OH 44890, #800-243-7379
- 4 Best Manufacturing Company, 4615 East 48th Street, Los Angeles, CA 90058, #213-583-9951 / 800-862-2660
- 5 Lab Safety Supply Inc, P. O. Box 1368 Janesville, WI 53547-1368, #1-800-356-0783
- 6 Chemical & Engineering News, May 12, 1997, p. 7



Appendix H - Particularly Hazardous Substances

This appendix is now on the EH&S web site, at
<http://www.ehs.washington.edu/manuals/lsm/lsmh.shtm>

