Chemical Hygiene
LABORATORY SAFETY PLAN

FOR THE

ERIC JOHNSTON SCIENCE CENTER

AT

WHITWORTH UNIVERSITY

300 W. HAWTHORNE RD.
SPOKANE, WASHINGTON 99251-3903

January 2010

We extend our thanks to Mr. Jim Kapin of the University of California at San Diego for his gracious assistance in allowing us to emulate elements of that school's Laboratory Safety Plan.

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Table of Reviews and Revisions

Review Date	Review Team	Comments	Date Changes Were Distributed
12/2009	Science Safety Committee	Change titles and contact info	1/4/10

Introduction

How to Use This Plan

Each faculty member, staff member and student worker must complete an orientation to the Lab Safety Plan (LSP) chapters relevant to the work they do or plan to do. They must sign a copy of a training sign-in sheet or other documentation that they have received the training. The plan must be reviewed annually by the Chemical Hygiene Officer and the Laboratory Safety Committee. All lab spaces should be audited for compliance with the LSP twice a year -- once by the Chemical Hygiene Officer and once by the primary faculty member using or teaching in the space. A self-inspection form is contained in Appendix A.

Purpose

The primary purpose of this plan is to minimize hazards, illnesses and injuries to faculty, staff, students, contractors and visitors in Whitworth's Chemistry, Biology and Physics departments. It is designed to help faculty and staff members recognize, evaluate and control hazards in the laboratories. The specified work practices and procedures have been developed to provide optimal safety. Effectiveness of the plan depends on the cooperation of everyone concerned.

A secondary purpose is to minimize regulatory and other types of liability to the institution. To this end, the plan provides guidelines and procedures to assure compliance with a large number of local, state and federal regulations. It also includes published practices, standards and guidelines of nationally recognized health and safety groups. The regulations and guidelines are listed in Appendix B.

Rights

Whitworth faculty, staff members, students and visitors have a right to a safe, healthful work environment. Laboratory research and teaching must be done safely, as described in this plan. This plan is available to all employees and their designated representatives and, upon request, to the director of the Washington State Department of Labor and Industries.

Roles and Responsibilities

Several “categories of responsibility” are essential to the effective implementation of our Laboratory Safety Program. The following sections define the role of each of these parties in carrying out the program. Throughout this plan, employees with specific responsibilities are identified. If, because of promotion or other reasons, a new employee is assigned any of these responsibilities the Chemical Hygiene Officer is to be notified of the change so that they can update their records.

University President and Administrative Staff

The University President and administrative staff are responsible for ensuring that research and instruction are conducted in compliance with federal, state and local regulatory requirements in addition to Whitworth policy and applicable granting agency requirements. They support the lab safety program by budgeting adequate funds and hiring qualified persons to operate it. They

have also delegated to each department chairperson the responsibility for safety performance within their respective departments.

Manager of Environmental Health, Safety & Security

Manager of Environmental Health, Safety & Security is responsible to support the lab safety program by budgeting adequate funds for hazardous waste disposal. He or she is also a member of the Laboratory Safety Committee (see below).

Manager of Custodial and Maintenance Services

The Manager of Custodial and Maintenance Services is responsible to support the lab safety program by promptly assigning employees to carry out needed repairs and maintenance, and by budgeting adequate funds for building systems maintenance.

Chemical Hygiene Officer

The Chemical Hygiene Officer (CHO) is responsible for overall management of the laboratory safety program for the entire facility. His or her responsibilities include but are not limited to:

- Working with administrators and other employees to develop and administer policies and practices needed to support the effective implementation of the program.
- Collecting and maintaining a suitable reference library of laboratory safety regulations, consensus standards, and other chemical safety information.
- Knowing and staying current on legal requirements concerning regulated substances and laboratory safety.
- Monitoring procurement, storage, use and disposal of chemicals in our facility.
- Developing and implementing policies and procedures to minimize hazardous waste generation.
- Conducting periodic equipment performance checks, facility inspections, and audits to ensure compliance with regulations and with the Laboratory Safety Plan.
- Conducting and documenting the required hazard analyses to determine appropriate engineering controls and levels of personal protective equipment for all hazardous operations in the laboratories.
- Ensuring that required personal protective equipment is available, in the proper sizes, and in working order.
- Developing, scheduling, documenting, and periodically reviewing suitable laboratory safety training programs as required and as appropriate.
- Acting as facility liaison during inspections by the Department of Labor & Industries, the Department of Ecology, local fire officials, or any other authorized inspection agency.
- Delegating responsibility to other appropriate personnel for performing various tasks in support of the program (e.g., conducting training, requesting and processing Material

Safety Data Sheets, labeling containers, conducting facility inspections, treating hazardous wastes, serving as alternate CHO).

- Continually searching for ways to improve the program.
- Leading the annual review of the Laboratory Safety Plan, and making such revisions as may be appropriate.

Laboratory Safety Committee

The Laboratory Safety Committee is composed of:

- One professor each from the Biology, Chemistry and Physics departments;
- The Chemistry Lab Manager
- The Biology Lab Coordinator
- The Art Department Safety Coordinator
- the CHO; and
- the Manager of Environmental Health, Safety & Security

Their responsibility is to support the CHO in carrying out his or her duties.

Science Department Employees

Faculty, staff, and student employees in the science departments are responsible to:

- Complete an orientation to the Lab Safety Plan chapters relevant to the work they do or plan to do. They should sign a copy of each chapter summary sheet and keep them for reference.
- Attend the laboratory safety training sessions arranged by the CHO.
- Become familiar with information on the Material Safety Data Sheets and other available reference materials regarding the hazardous chemicals in their work area.
- Observe appropriate handling precautions noted on the Material Safety Data Sheets and/or discussed in the training sessions.
- Develop good personal chemical hygiene habits.
- Plan and conduct all operations in accordance with our established chemical hygiene procedures and practices.
- Obtain approval from the CHO before performing special operations and non-routine tasks in which hazardous chemicals are involved.

In addition:

- Faculty members are responsible to oversee students in the labs, ensure that they are aware of potential hazards, and that they follow appropriate safety practices.

- Science department secretaries are responsible for working with the Chemical Hygiene Officer to maintain the Material Safety Data Sheets.

Periodic Review

This plan will be reviewed and updated at least annually by the Laboratory Safety Committee. A record of the changes will be kept in the CHO office. Changes made will be distributed to Science Faculty and Staff.

Laboratory Safety Plan Training Sheet

The Laboratory Safety Plan (LSP) is to be updated annually by the Laboratory Safety Committee and reviewed by all lab personnel.

- At initial assignment and at least annually thereafter, all lab workers must receive from the Laboratory Safety Committee or the Chemical Hygiene Officer a copy of the following page that indicates which sections of the LSP apply to their job duties. They must review each of these sections and sign and date the appropriate blank. Each lab worker is responsible to complete this training and forward a copy of this signed and dated page to the Chemical Hygiene Officer to be kept in a permanent training documentation file.

- Upon revision, updating, additions, deletions, or other changes to the plan, all lab workers must receive from the Laboratory Safety Committee or the Chemical Hygiene Officer a copy of the following page indicating which sections of the LSP applicable to their job duties have changed. They must review each of these sections and sign and date the appropriate blank. Each lab worker is responsible to complete this training and forward a copy of this signed and dated page to the Chemical Hygiene Officer to be kept in a permanent training documentation file.

This training requirement applies to **all** employees who work in the Science Building – permanent faculty, adjunct faculty, staff, and student workers.

Laboratory Safety Plan Training Sheet:

Employees must read each chapter indicated for their position and sign and date the adjacent line. Turn in completed forms to the CHO. The Lab Safety Plan is located at:
http://www.whitworth.edu/Academic/Resources/Science/Safety/ChemicalHygienePlan.htm
Employee's Name: _____ Date: _____
Department: Job Title:

	Signature	Date
General Safety:		
1. ☒ Worker injuries & worker compensation		
2. ☒ Emergency Preparedness		
3. ☒ Fire Safety		
4. ☒ Electrical Safety		
5. ☒ Hand & Power Tools		
6. ☒ Laboratory Ergonomics		
7. ☐ ~~Laboratory Relocation & Vacating~~		
Chemical Safety:		
8. ☐ Chemical Safety		
9. ☐ Chemical Procurement		
10. ☐ Chemical Storage & Inventory Control		
11. ☐ Fume Hoods and Engineering Controls		
12. ☐ Personal Protective Equipment		
13. ☐ Handling Chemical Emergencies		
14. ☐ Disposing of Hazardous Waste		
Specific Safety Issues		
15. ☐ Carcinogens and Reproductive Toxins		
16. ☐ Controlled Substances		
17. ☐ Highly Toxic Substances		
18. ☐ Exposure Monitoring		
19. ☐ Peroxide Formers & Potential Explosives		
20. ☐ Compressed and Hazardous Gases		
21. ☐ Operational Hazards		
a. ☐ Centrifuge Safety		
b. ☐ Safe Sonication		
c. ☐ Quenching Stills		
d. ☐ Water-cooled Equipment		
e. ☐ Vacuum Pumps & Systems		
f. ☐ Steam Autoclaves		
g. ☐ Magnetic Fields		
22. ☐ Cryogenic Liquids		
23. ☐ Human Subjects		
24. ☐ Animal Use		
25. ☐ Blood-borne Pathogen Control & Biosafety		
26. ☐ Radiation Safety		

Chapter

1

Chapter 1 – Worker Injuries and Workers' Compensation

In The Event Of A Medical Emergency:

- Remain calm and begin lifesaving measures as required.
- Call for emergency response (Call **9-911**) if necessary -- request an ambulance if needed.
- Keep the injured person warm.
- Do not remove the injured person unless there is a danger of further harm.

Contact one or more of the following for further medical assistance:

Whitworth Health and Counseling Center ..... x3259 (from campus phones)
(Students with non-emergency minor injuries -- Schumacher)

US Healthworks 467-4545
(injured employees -- 9222 N. Newport Hwy., Suite E)

Rockwood Urgent Care ……509-744-1700
(Injured students or employees –9001 N. Country Homes Blvd.

Holy Family Hospital Emergency Dept. 482-2460
(emergency medical help -- 5633 N. Lidgerwood)

- If medical attention is required due to a chemical exposure, a copy of the Material Safety Data Sheet for the chemical(s) should be taken to the medical facility with the injured person.

Worker's Compensation

The objective of the Worker's Compensation program is to bring about your expedient recovery and return to productive work. The Whitworth Human Resources staff helps provide benefits and assistance to Whitworth employees who either are injured or develop a job-related illness as a result of their employment. Benefits may include Medical Care, Temporary Disability, Permanent Disability, Vocational Rehabilitation and Death Benefits. As soon as possible after an injury or illness the employee's supervisor should complete an Accident Report Form (see Appendix C) and submit it as directed on the form within 24 hours of the injury. This will serve to notify the Human Resources staff.

First Aid

Each lab should have one or more small first aid kits in a location easily accessible to all lab personnel, for treating minor lab injuries. All first aid kits used in the Whitworth science departments shall have, as a minimum, the following items. These are minimum requirements; personnel may supplement kits according to their needs. Additional items may be necessary where special hazards are present (e.g., hydrofluoric acid, organophosphates, cyanides, etc.). Check your first aid kits regularly and restock them after each use!

Required Minimum Contents:

- 2 antiseptic wipes
- 5 one-inch adhesive bandages
- 1 2"x2" or larger gauze pad
- 1 adhesive tape
- 1 CPRotector
- 2 burn jel packets
- 2 extra-large adhesive bandages
- 1 roller gauze
- 1 pair of latex or nitrile gloves

The contents of the Laboratory First Aid Kit have been reviewed by appropriate medical personnel to ensure it is adequate for minor injuries that may occur in the lab. This kit is only intended for minor injuries and to provide protection if cardiopulmonary resuscitation (CPR) is required. Seek medical attention by dialing **9-911** for all medical emergencies.

The CPRotector and the gloves are provided in each kit to minimize contact with blood or body fluids, as part of Whitworth's blood-borne pathogen control program. If the injured person is bleeding, gloves should be donned by anyone providing first aid, before starting to do so. If the bleeding is severe and/or spurting, goggles should also be worn to prevent exposure to the eyes. Prompt evaluation is important if a person has been exposed (by needle stick, splash, or direct contact) to human/primate blood or body fluids:

- First: wash the wound/ area thoroughly with soap and water.
- Then seek advice (treatment may also be included) from the appropriate medical facility listed above.

Spilled blood should be covered with a solution of one cup of liquid bleach (5.25% sodium hypochlorite) per gallon of water, and let stand for 5 minutes to disinfect it. The mixture can then be absorbed on spill pads, placed in a sealed labeled glass jar, and autoclaved as described under "Infectious Waste" in Chapter 14.

All lab workers should also understand the emergency response procedures in Chapter 2 and 13, and know the locations of emergency showers, fire extinguishers and other emergency equipment. Proper use of this equipment will save lives and minimize damage to personnel and property.

The first response for all chemical spills is to rinse the affected area with fresh water for at least 15 minutes (the exposed person will need assistance with this) using an eyewash/deluge shower. If an eyewash/deluge shower is not immediately available, a portable eyewash bottle may be

provided for first response, to be followed immediately by getting the exposed person to an eyewash/deluge shower where the necessary rinsing can continue.

Certain chemicals pose hazards that require a specific antidote in the laboratory. All lab personnel working with hydrofluoric acid should have calcium gluconate gel in the lab in case of exposure and should understand its use. Lab personnel working with organophosphates or cyanides may also need specific antidotes. Contact the Chemical Hygiene Officer for more information.

Part of the lab safety training should include locations of telephones available for emergency use. Emergency telephone numbers are posted on or near the nearest telephone.

Chapter
2

Chapter 2 – Emergency Preparedness

Emergency Preparedness

"Communities throughout the Pacific Northwest are subject to a number of potential natural disasters such as fires, flooding, severe storms, earthquakes, dam failures, volcanic eruptions and landslides. While we all hope that such occurrences never happen, it has been shown repeatedly that being prepared for disasters is prudent. Emergency services and government agencies may not be able to respond to your needs immediately. Their buildings, equipment, personnel, communications, and mobility may be severely hampered by the event. They will be overwhelmed. Experts tell us to plan to be on our own for a minimum of 3 days."

-- Spokane County Dept. of Emergency Management website

Natural disasters are a constant possibility. In order to be prepared, laboratory workers should take basic steps to prepare for a disaster to mitigate damage and to speed recovery after a disaster.

- Each department has designated a primary and secondary emergency contact for after-hours emergencies, as shown in the table below. Campus Security has also been notified of these designations.

		Name	Title	Travel time to campus	Home Phone	Office Phone
Biology	P	Debbie Harris	Biology Lab Coordinator	5 minutes	465-1892	777-3266
	S	Finn Pond	Associate Professor	5 minutes	466-3036	777-4500
Chemistry	P	Joy Diaz	Chemical Hygiene Officer	30 minutes	509-747-7223	777-4339
	S	Deanna Ojennus	Assistant Professor	5 minutes	468-2664	777-4860
Physics	P	Richard Stevens	Associate Professor	20 minutes	468-7759	777-4508
	S	John Larkin	Assistant Professor	10 minutes	467-2532	777-4865

- If the building must be evacuated, all persons should gather on the front lawn to be accounted for. Department heads or their designees are responsible to account for department

employees and visitors. Faculty members are responsible to account for each student in their classes.
- Assign a "buddy" to help evacuate any disabled persons.
- Access and egress pathways leading from each lab to the hallway and from the hallway to the outdoors should not be blocked with stored equipment, boxes, or furniture. The hallways and stairwells of the Science building are fire-rated egress ways, and must not contain accumulations of flammable or combustible materials.
- Store copies of all critical research documentation outside the laboratory to avoid the total loss of research data in case of fire, etc.
- Obtain information regarding back-up resources (i.e., freezers, refrigerators, incubators, etc.) to preserve critical cell lines, organisms, etc.
- Keep a roll of plastic sheeting on hand for use in case of flooding from broken pipes, etc.
- To minimize damage in an earthquake, all tall objects should be secured to a wall or other support. Large heavy objects should not be stored on shelving units.
- All open shelves, especially chemical storage shelves, should have lips to keep containers from falling.

Security

For the safety of everyone in the science building, it is important to take measures to prevent unauthorized access to labs and to act to prevent violent assaults. The following measures are recommended:
- Keep the doors of laboratories and chemical storage areas locked when they are not in use.
- Keep unauthorized persons out of chemical storage areas.
- Do not store unneeded chemicals in laboratories -- return them to the proper storage area.
- Store purses and other valuables out of sight, and locked up if you are leaving the room.
- Report any suspicious objects, activities or persons immediately to Campus Security, x3256.
- Workers concerned about leaving the building after dark may wish to leave together, or call Campus Security for an escort.

Chapter
3

Chapter 3 – Fire Safety

It is better to prevent fires than fight fires! Review the materials in Chapters 4, 8, 10 and other applicable chapters to reduce the potential for fires. If a fire occurs, all lab personnel should know how to report fires, the location and proper use of fire extinguishers in their work area, and how to evacuate the building.

To report a fire -- call **9-911** and quickly evacuate the area, closing the door as you leave. If the fire alarm has not sounded, activate the alarm pull station near the building exit door as you leave, to notify anyone else who may be in the building.

Personnel should only use an extinguisher for SMALL (trashcan size) fires, and only if there is an escape route behind them. It is important to be aware of the locations and types of the fire extinguishers available. Fire extinguishers need to be charged annually (this is handled by Facility Services) and inspected monthly (by the Chemical Hygiene Officer) to verify their readiness.

Partially discharged extinguishers must be immediately reported to Facility Services at x3254.

Pyrophoric chemicals, air and water reactive chemicals, flammable metals and chemicals that give off toxic by-products or rapidly polymerize when burnt require special fire-fighting procedures. See the Chemical Hygiene Officer for advice regarding these.

Gas System Emergency Shut-Off

There is a red emergency gas shut-off button mounted near one of the exit doors in each of the Chemistry teaching labs, rooms 214, 221 and 227 and in the microbiology lab, room 327. When activated, they shut off the natural gas supply to the entire building.

The emergency gas shut-off should be used in case of any fire in an area of the Science Building that has natural gas supply, particularly the Chemistry teaching labs.

To reactivate service, first make sure that the emergency has ended. Then pull the button out and press the reset switch located to the left inside the door of the first-floor mechanical room.

Fire Extinguishers

Take the time to learn about the extinguishers in your area. Having the right extinguisher, knowing its location and knowing how to use it can save lives and property.

The National Safety Council estimates that most fires occurring in the Unites States are easily contained with a single fire extinguisher at the time the fire is first discovered. Whitworth utilizes two basic types of extinguishers -- carbon dioxide and dry chemical -- depending on the material burning. You can't use all types of extinguishers safely on all types of fires!

Each extinguisher bears a letter rating -- A, BC or ABC -- and one or more pictograms (see below) on its label, which informs the user of the type of fire the extinguisher can be used safely for. Carbon dioxide extinguishers can be used on "B" and "C" fires. Dry chemical extinguishers can be used on "A," "B" or "C" fires. If there are combustible metals (sodium, potassium, magnesium, etc.) in the lab, a container of sand or soda ash should be available. The quantity of sand or soda ash will need to be enough to make a pile completely covering (and smothering) the burning metal.

Class A Fire involves ordinary combustible materials (wood, paper, etc.)

Class B Fire -- Involves burning liquids (solvents, paint, etc.)

Class C Fire -- Involves energized electrical equipment.

The fire-fighting agent in ABC extinguishers is a very fine mixture of mono-ammonium phosphate and anti-caking agents. If an ABC extinguisher is discharged, carefully sweep or vacuum the residue and wipe off all surfaces thoroughly. This material has a very low toxicity, but the dust can be irritating. Make sure there is plenty of fresh air during clean up.

Review the extinguishers in your area to make sure they are appropriate for the materials used. Official monthly inspections of all fire extinguishers in the building are carried out by the CHO or his/her designee. Every extinguisher is recharged annually by the Facility Services office.

Call 777-3254 to report fire extinguisher problems.

Using A Fire Extinguisher Safely – P-A-S-S

Learn about extinguisher operation before you need the extinguisher. They are very simple to use, but practice can prevent a disaster. Although extinguishers vary in size, color and type of extinguishing agent, the vast majority of them operate basically the same way. Stand six to eight feet from the fire with your back to an unblocked exit. If the fire is small, heavy smoke is NOT present, and you have an exit available to you for evacuation purposes, grab the nearest appropriate extinguisher and perform the following P-A-S-S procedure:

P - Pull the pin located in the extinguisher's handle (twist to break the seal).

A - Aim the nozzle, horn or hose at the base of the fire.

S - Squeeze or press the handle.

S - Sweep from side to side at the base of the fire until it is out.

Always back away from a fire you've just put out, and keep an eye on it in case it flares up again.

Call the Chemical Hygiene Officer to arrange for hands-on fire extinguisher training.

Chapter
4

Chapter 4 – Electrical Safety

Electrical hazards cause many fires on campuses each year. They are also one of the leading causes of workplace fatalities in the United States. To protect against electrical hazards and to respond to electrical emergencies it is important to identify the electrical panels that serve each lab space. Access to these panels must be unobstructed and they must be clearly labeled.

Room(s)	Panel ID	Panel Location	Receptacles/circuit breaker Identification
106	B2-1 & B2-2	West corridor	19,21,23,25,27,29,31,33,43,45
114	B2-1	West corridor	8,10,12,14,16,18,20
121	B1-2	North corridor/study are	44,46,48,50,52,54
137	B1-1	North corridor/study are	22,24
204	C2-1 & C2-2	West corridor	41,43,45,49
204	E	Electrical room 141	8
209	C2-1	West corridor	22,24
214	C2-1	West corridor	21,23,25,27,29,31,33,35
217	C1-2	North corridor	61,63
219	SPE	Room 219	1,3
219	C1-2	North corridor	61
221	C1-2	North corridor	48,50,52,54,56,57,58,59,60,61,62,63,65,67
221	E	Electrical room 141	10
227	C1-1 &C1-2	North corridor	24.26.28.30.32.34.36.38.40.42.43.44.45.46.70
227	E	Electrical room 141	45
304	D2-1 &D2-2	West corridor	29,31,33,35,37,39,41,43,45,47,49,51
321	D1-2	North corridor	53,55,57,59,61,63,66,68,70,
323	D1-2	North corridor	45,46,47,48,50,52,54,56,58,60,70
327	D1-1 &d1-2	North corridor	25,27,29,31,33,35,37,38,39,41,43,45

In addition, it is important to prevent fire and shock hazards in labs, by observing the following precautions:

- Do not use extension cords for permanent wiring on fixed equipment. They may be used for portable equipment. Do not run extension cords through walls, windows or doors.
- Electrical cords on equipment must be in good condition, not frayed or cracked. Damaged cords must be removed or repaired, not taped over.
- Multi-outlet power strips must have overload protection (circuit breaker) and must not be connected to another power strip or extension cord.
- Electrical cords and extension cords must plug directly into the wall without adapters. An electrician should do all repairs and modifications.
- Ground Fault Circuit Interrupters (GFCI) must be used in wet areas around sinks, tanks, etc.
- If a piece of equipment causes the GFCI to trip out, it is defective and should not be used until it has been repaired, to avoid the risk of electrocution.

Chapter

5

Chapter 5 – Hand & Power Tools

Hand and power tools are used in a wide variety of operations in the Science Building, including minor office repairs, lab equipment repairs, and construction of various apparatus.

Hand Tools

- All hand tools should be kept in good repair and used for the purpose for which they were designed.
- Screwdrivers with broken or chipped blades should not be used.
- Punches, chisels or other hammer-driven tools that have developed “mushroomed” heads should not be used.
- Striking tools (hammers, mallets, etc.) must have the handle firmly attached to the head to prevent the head from flying off.
- Do not attempt to repair hand tools with tape, wire, or by other improvised means.

Power Tools

The following power tools are stored in the Physics department shop, Room 132. Some of them are sometimes used by the other two departments as well.

Portable Power Tools

Circular saw	Drill	Belt sander
Pad sander	Heat gun	Soldering iron
Compressed air hose		

Non-Portable Powered Equipment

Bandsaw	Pedestal grinder	Vertical belt sander
Radial arm saw	Bench grinder	Drill press
Lathe	Milling machine	12-ton hydraulic press
Arc welding machine		

Non-Portable Manually-Powered Equipment

Sheet metal brake	Sheet metal shear	Small press

Guidelines for Use

- Eye protection (safety glasses with side shields as a minimum) is required when using powered tools, to protect against chips and other particles entering the eyes.
- Keep hands, clothing, etc. away from moving parts of machinery.
- Avoid wearing loose clothing, dangling jewelry, neckties, etc. around moving machinery.
- All portable and non-portable powered tools must be guarded in such a way that prevents persons from getting any part of their body inadvertently into any locations where there is a hazard of getting cut, caught on, caught in, pinched, shocked or otherwise injured.
- Equipment guards must be in good repair and operate smoothly over their entire intended range of motion.
- For specific guidance on the design of guards for various types of equipment, see WAC 296-24, Part H-1, or consult the local office of the WA Dept. of Labor & Industries WISHA Consultation Service, 324-2600.
- Powered equipment can produce high noise levels. The permissible limit for noise exposure is 90 decibels on the "A" scale (dBA). A handy rule of thumb is that if the noise is loud enough that you have to raise your voice to be heard at 2-3 feet away, it's too loud!
- Use hearing protection (earplugs or muffs with a noise reduction rating (NRR) of at least 15; higher is more protective) whenever you are exposed to loud noise as described in the paragraph above.
- Compressed air must not be used for cleaning purposes unless the pressure is reduced to less than 30 psi, and then only with effective personal protective equipment to prevent eye injury.
- When being maintained or repaired, powered equipment must be unplugged from the power source, all other sources of energy (compressed gases, suspended weights, etc.) neutralized, and the plug must stay in the control of the person doing the work. This is to prevent unexpected movement of the equipment, which could cause injury.

Chapter
6

Chapter 6 – Laboratory Ergonomics

The purpose of an ergonomics program is to reduce or eliminate hazards that contribute to the development of cumulative trauma disorders (CTDs) -- a class of disorders related to repetitive motions. Ergonomic injuries are one of the fastest growing categories of workplace related injuries in the United States.

Applying ergonomic principles can help reduce the risk of injuries or illnesses for those who work with computers, in laboratories, in jobs that require repetitive activities and in heavy materials handling. Pipetting, microscope work, computer use and improper lifting techniques are common causes of problems in labs.

Risk factors for CTDs include repetitive tasks, awkward postures, vibration, forceful exertions and heavy lifting. Allow your body to recover after these activities.

- Take frequent breaks
- Move around
- Don't repeat the same motion for hours on end
- Avoid awkward motions and postures
- Perform relief exercises
- Expand the tasks each person performs to minimize the constant repetition of any one particular task

Awkward postures, repetitions, and use of force are not bad in themselves, however when sustained over long periods of time, thereby not giving your body the time to recover can lead to: overexertion, injury and perhaps permanent damage.

The Pressure of Pipetting

Pipetting involves several ergonomic stresses that can be exacerbated by the mental pressure resulting from the accuracy, precision and timing demanded in many pipetting procedures. If you spend more than one hour per day pipetting: Do the following:

- Rotate pipetting tasks among several people.
- Take short micropauses of a few seconds, when you can't take a longer break.
- Choose pipetters requiring the least pressure and use only the force necessary to operate the pipetter.
- Work with arms close to the body to reduce strain on shoulders. Don't elevate your arm without support for lengthy periods. Keep head and shoulders in a neutral position (bent forward no more than 30 degrees).
- Use adjustable chairs or stools with built-in foot rests. If using a foot ring, move your feet occasionally to avoid compressing blood vessels in feet. Don't use a high stool that can force you to work with a bent neck.
- Use shorter pipettes and low profile waste receptacles for used tips. This decreases hand elevation and consequent awkward postures.

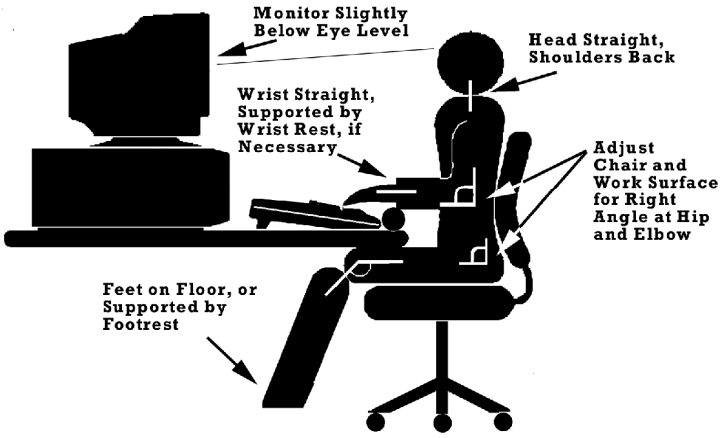
Microscopes

- Don't use a microscope more than five hours per day; spread use out over the entire day.
- Keep scopes cleaned and use illuminators and shadow boxes properly to avoid visual and musculoskeletal strain.
- Adjust chair height so thighs are horizontal and feet flat on the floor.
- Make sure the backrest provides proper lumbar support and be sure to readjust when you change positions.
- Select chairs with padded armrests to avoid compressing the ulnar nerve in your arm.
- Position work surfaces high enough to allow close inspection without inclining your head beyond 17-29 degrees.
- Use a cutout worktable if available. This places you closer to the scope and provides an area for supporting your forearms.

Healthy Computer Use

It is the responsibility of each computer operator to recognize the risks associated with computer use and to take proactive, corrective measures to reduce potential injuries.

The following is a "quick reference" checklist that identifies some ergonomic issues associated with computer use. Follow the guidelines below to achieve a neutral, relaxed posture.



- Sit directly in front of monitor and keyboard.
- Make sure the top of the screen is at eye level.
- Check for glare -- close blinds, reposition the monitor, place a shade over the screen, install a glare shield.
- Maintain an approximately 90-degree angle in elbows.
- Keep wrists straight and aligned with forearm.
- Sit "snugly" in chair to keep lower back well supported.
- Keep arms close to body when typing or using mouse.
- Move entire hand/wrist area when operating a mouse.
- Bring frequently used items close to work area to avoid overreaching and repetitive stretching.
- Place feet firmly on the floor or footrest.
- Move yourself around the work area using your feet, rather than pulling with your hands.
- Allow adequate legroom under the workstation for stretching and periodic position changes.

Lifting and Materials Handling Guidelines

Proper Lifting Techniques Can Help Prevent Injuries!

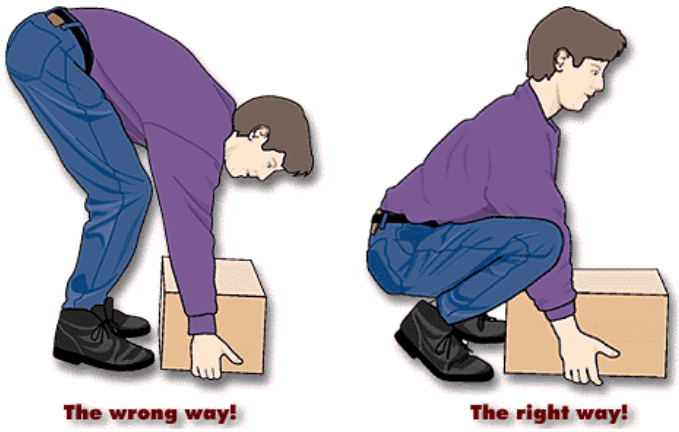
The human back is a column of 33 vertebrae separated by small, round discs filled with a thick fluid, all held together by ligaments and muscles. If the ligaments and muscles are weak, the vertebrae and discs can become misaligned. Excessive lifting, a sudden fall, or other traumatic action can injure the back or, over a period of years, the discs may simply "wear out". You can also “strain” or “sprain the muscles and ligaments in your back.

Poor physical condition, poor posture, lack of exercise, and excessive body weight contribute to the number and severity of back injuries. Degeneration of the spine due to aging is also a major contributor to lower back pain, but is frequently misdiagnosed as a sprain or strain.

Before you lift anything, think about the load you'll be lifting. Ask yourself: can I lift it alone? Do I need mechanical help? Is it too awkward for one person to handle, or should I ask a coworker for help?

If the load is manageable, there are seven rules for safe lifting to help minimize injuries to the back: Be sure to use the same safe techniques when you set your load down. It takes no more time to do a safe lift than it does to do an unsafe lift, so why not play it safe and lift it right?

- **Lift Comfortably**. Choose the position that feels best, with or without a straight back.
- **Avoid Unnecessary Bending**. Do not place objects on the floor if they must be picked up again later.
- **Avoid Unnecessary Twisting.** Turn your feet, not your hips or shoulders. Leave enough room to shift your feet so as not to have to twist.
- **Avoid Reaching Out.** Handle heavy objects close to the body. Avoid a long reach to pick up an object.
- **Avoid Excessive Weights.** If the load is too heavy, get help or use a mechanical device, if possible.
- **Lift Gradually.** Lift slowly, smoothly and without jerking.
- **Keep in Good Physical Shape.** Get proper exercise and maintain a good diet.



Resource: Ergonomic Analysis Software

Ergonomics Education, Awareness, System Evaluation and Recording, ErgoEASER, is a software package developed to aid in identifying, evaluating, and preventing work-related musculoskeletal disorders. Evaluating video-display terminal (VDT) workstations and lifting task design, ErgoEASER offers suggestions on how to address ergonomic hazards and reduce worker disabilities.

The Department of Energy, Pacific Northwest National Laboratory, and other agencies combined efforts to develop this innovative software, which is available as a free download from:

http://nattie.eh.doe.gov/others/ergoeaser/download.html

Chapter
7

Chapter 7 – Laboratory Relocation and Vacating

Laboratory relocations and move-outs create the potential for a variety of problems, including accidents, injuries and chemical, biological and radiation spills. Before any moves, closures, or relocations of laboratory space, review these requirements. Labs also need to notify the Chemical Hygiene Officer of upcoming moves.

The faculty member or student researcher vacating lab space is responsible for removing **ALL** hazards from that lab space. Lab areas cannot be re-occupied and/or work cannot be performed by contractors until this is done. Use the Lab Clearance Checklist below to keep track of all the details.

Before You Move:

- Notify the Chemical Hygiene Officer of the move or move-out.
- Dispose of as much hazardous waste possible; see chapters 14 and 25 for information.
- Pack hazardous materials securely.
- All equipment must be cleaned or decontaminated prior to the move.

When you move:

- Contact the Chemical Hygiene Officer to move chemicals, compressed gases or radioactive materials. Contact the Chemical Hygiene Officer at 777-4339 for more information.
- Use proper lifting techniques when moving. If injuries occur, seek treatment and report them promptly to the Human Resources office. See Chapter 6 for information on lifting techniques and Chapter 1 for Workers' Compensation information.
- Proper packaging (see above) will prevent spills of hazardous materials. If a spill or release does occur, report it to the Chemical Hygiene Officer immediately (777-4339).

REMEMBER – An important part of the clearance process is removing items, such as razor blades, needles and even dust on shelves that could be perceived as hazardous by workers unfamiliar with research labs, such as movers, contractors and other personnel. See the Contractor Safety Sheet below for further information.

Whitworth Lab Clearance Checklist

Investigators vacating Whitworth facilities or relocating within the Science Building are responsible for leaving laboratories in a state suitable for re-occupancy or renovation. The CHO must be notified of all moves in lab spaces. Once the items below have been completed, sign and date the form and give it to the CHO. Space cannot be re-occupied and no work can be done in a space until this is completed.

Room: _____

General Housekeeping

- ☐ Notify the CHO of move (777-4339) and ensure new space is cleared for occupancy.
- ☐ Broken glassware and clean sharps removed in puncture-resistant containers.
- ☐ Laboratory equipment and supplies decontaminated before removal from laboratory.

Biohazardous Materials

- ☐ Work surfaces cleaned/ disinfected.
- ☐ All potentially biohazardous waste disinfected and removed from lab, including sharps boxes.
- ☐ All media and supplies removed from drawers, shelves, and cabinets.
- ☐ Biosafety cabinets decontaminated prior to moving and re-certified after the move. Contact the CHO (777-4339) for details.

Radioactive Materials

- ☐ Survey facilities and equipment by meter and wipe test for contamination. Forward a copy of the wipe test and corresponding map to the CHO.
- ☐ Surfaces and equipment cleaned, with radiation levels less than or equal to twice instrument background. If non-removable contamination is detected, contact the CHO.
- ☐ Radioactive waste appropriately packaged and removed.
- ☐ CHO contacted for final clearance and survey.

Chemical Safety

- ☐ All laboratory chemicals, including wastes, removed from the laboratory.
- ☐ All empty bottles and cans removed. Containers rinsed, defaced, and caps removed.
- ☐ Disposable liners/covers removed from work surfaces.
- ☐ Laboratory bench tops washed with soap and water.
- ☐ Debris removed from fume hoods and fume hood surfaces wiped down.
- ☐ Water run into all sinks and floor drains to fill traps. It is recommended that several tablespoons of mineral oil be poured in each drain to inhibit evaporation from the trap.
- ☐ CHO (777-4339) notified for testing if perchloric acid has been used in fume hoods.
- ☐ Signage or placarding for specific hazardous materials removed (i.e., carcinogens).

Signed:_____ Date:_____

Contractor Safety Sheet

Procedures when Contractors Work in Your Lab

Lab workers should always understand the work the contractors are doing, especially any actions that could affect lab operations. Contractors should not move laboratory equipment or chemicals without assistance and approval from lab workers.

If contractors are working in the lab, help them understand that:

- Biohazard signs indicate the use of biological organisms. These are generally well contained and researchers are trained to decontaminate work areas after use.
- Radiation devices or materials may be used in a few labs. All such labs should be checked if radioactive materials have been used by Science Faculty/Staff, to make sure the area was not contaminated. The CHO can also determine if an area is contaminated.
- Chemicals may be found in laboratory or research areas. With advance notice from contractors and/or facilities services personnel, lab staff will protect sensitive instrumentation and secure chemicals in all affected areas the contractor will be working in.

Entering a Laboratory – Contractors will not enter any area or laboratory with a sign that warns against unauthorized entry or says keep out, unless specifically directed to do so. Lab workers should keep this in mind if this applies to their areas.

Working In Fume Hoods - If the project involves significant work inside a fume hood, laboratory staff must remove equipment and supplies and wipe the inside surface of the hood. The hard gray panels on the inside of many older hoods are made of Transite, containing asbestos. Removal of Transite or other asbestos must be coordinated with the Chemical Hygiene Officer.

Working in an Unoccupied Space - When researchers leave an area, lab staff must remove materials, decontaminate surfaces and wipe down work areas. After hazards are removed, a completed Lab Clearance Checklist documents the work that was done. Contractors should understand that hidden hazards might still exist, such as broken glass or needles. Contractors should contact lab personnel or their supervisor with questions about potential hazards.

How should contractors protect themselves from hazards in laboratories?

- Do not eat or drink in a lab and wash hands after leaving lab.
- Wear gloves, such as single use, surgical type nitrile gloves.
- Wear eye protection and protective clothing such as a lab coat or coveralls.

If they are going to work with equipment that might generate heat or sparks, it is extremely important that flammable materials are safely stored away from the work area before they begin work. All gas cylinders should be secured before work begins.

What should contractors do if an emergency occurs?

- **Fire** - use a fire extinguisher if they are trained and the fire is small enough. For all other fires, evacuate the area, close the door, pull the fire alarm and call 9-911.
- **Spill** - If any chemicals, biological, or radioactive materials are spilled, they should notify others in the area, close the door and call for assistance at 777-4339.
- **Injury –** The closest Emergency Room to campus is at Holy Family Hospital.

Chapter

8

Chapter 8 –Chemical Safety

The key to chemical safety is the recognition, evaluation and control of hazards. There are a variety of resources, including **Material Safety Data Sheets (**MSDSs), to help gather basic information about chemicals, including hazard information (toxicity, reactivity, flammability and corrosivity) and physical properties (state, volatility, odor). It may be necessary to do further research to evaluate the degree of hazard posed by a chemical. The result of the research process should be a set of guidelines including engineering controls, work practices and personal protective equipment (PPE). These guidelines should be written into lab procedures or as separate safety SOPs.

MSDSs contain information on chemical identification, composition, physical properties along with health, physical, and environmental hazards. Other sections include emergency and first aid procedures, handling and storage procedures. The MSDS will discuss engineering controls for handling the material, and personal protective equipment that should be used. Most MSDSs also provide stability and reactivity information, toxicology, ecological information, disposal considerations, transport and regulatory Information.

Chemical manufacturers and distributors must distribute MSDSs, and chemical users must have them available in the workplace during all working hours. Because computer systems are not always up and working, paper copies are required. Faculty must verify that printed copies of MSDSs for the chemicals in their labs are available, preferably from the manufacturer that supplied the chemical. Frequently however, MSDSs are of limited value for laboratory researchers. Other sources of chemical safety information include the references listed below. A variety of electronic resources can also be accessed through the Internet.

Chemical Safety References:

- Paper copies of MSDSs maintained in room 209
- Manufacturer's MSDSs posted on the Internet
- “Prudent Practices in the Laboratory” **
- “CRC Handbook of Laboratory Safety” **
- Bretherick's "Handbook of Reactive Chemical Hazards" **
- "Hawley's Condensed Chemical Dictionary" **
- "Safe Storage of Laboratory Chemicals" **
- "Hazardous Materials Classification Guide" **
- Sax’s "Properties of Dangerous Materials"
- The Merck Index

** These and several other references are available in the CHO's office.

Whatever method is adopted, every lab worker should know how to access manufacturer specific hazard information for the chemicals they work with. Lab personnel should also be familiar with the Chemical Hazard Assessment Guide below for information on a variety of electronic resources.

Basic Chemical Handling Procedures

General Safety Practices

- Keep the work area clean and uncluttered.
- Do not leave exposed sharps (needles, razor blades, etc.) unattended.
- Label all containers and keep containers closed except when in use.
- Know the locations of fire extinguishers, eye washes and safety showers.
- Wash hands frequently and before eating.
- Do not eat, smoke or apply cosmetics in the lab.
- Clean up all spills promptly and properly.
- Wear shoes that completely cover the feet, and pants or longer skirts that provide leg coverage.
- Avoid exposure to hazardous materials - wear proper personal protective equipment.
- Horseplay, practical jokes, or other acts of carelessness are prohibited.

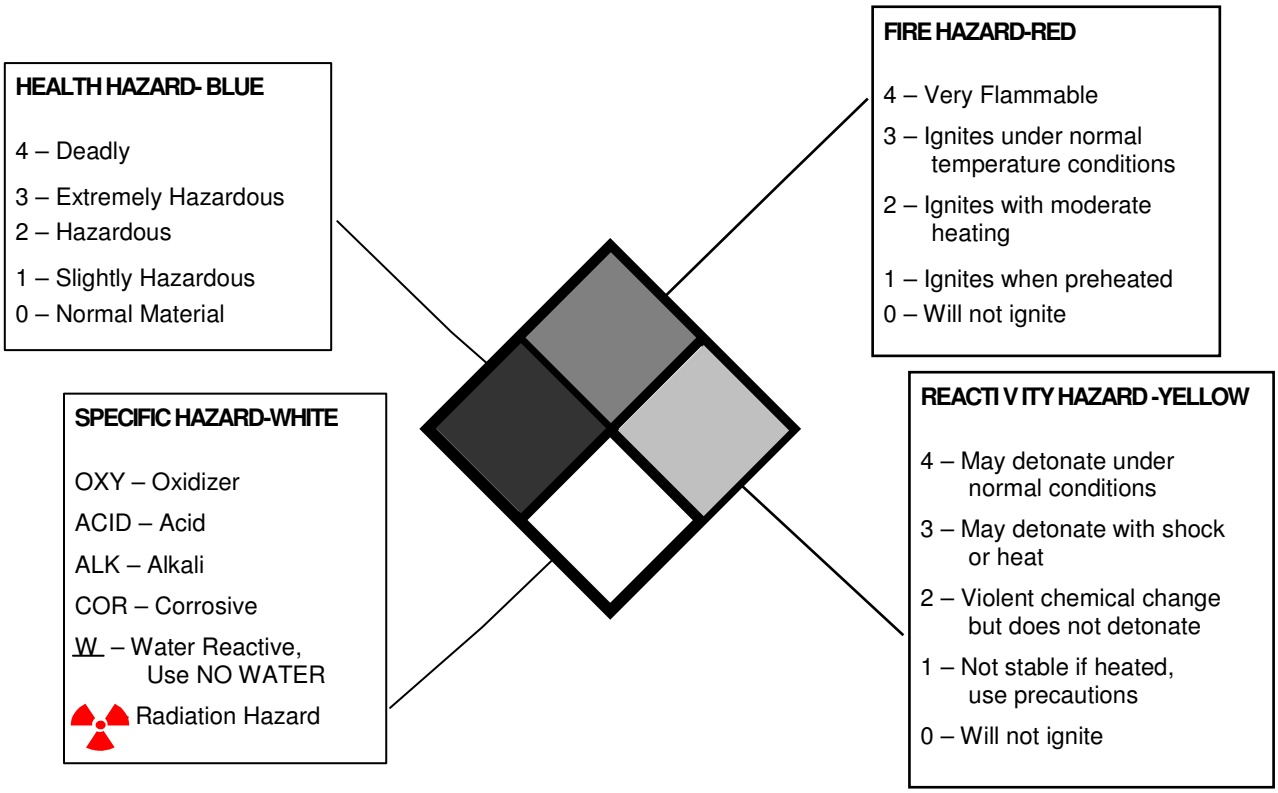
General Practices for Handling and Storing Chemicals

- Minimize all chemical exposures. Approach all chemicals as hazardous and use common sense - do not taste chemicals, avoid smelling chemicals and do not mouth-pipette.
- Do not work alone when handling hazardous materials and do not leave on-going reactions or operations unattended without adequate safety measures.
- Restrict the amount of chemicals ordered, kept on hand, and used. Substitute less hazardous chemicals when possible.
- Avoid underestimating the risk. One should assume that any mixture will be more toxic than its most toxic component and that all substances of unknown toxicity are highly toxic.
- Splash-resistant goggles should be worn in the laboratory.
- Wear proper gloves when working with any hazardous or potentially hazardous materials.
- Warning signs should be posted near any dangerous equipment, reaction, or condition.
- Use fume hoods and other ventilation devices to control exposure to airborne substances.
- All containers must be labeled with at least the chemical name, concentration, and appropriate hazard warnings.
- Store chemicals by hazard classification, not by alphabetical order. Do not store materials in fume hoods or on the floor.
- Flammable materials should be stored in approved containers.

Chapter
8.5

Chapter 8.5 NFPA Code: What does it mean?

The National Fire Protection Agency has developed a system to characterize Hazards associated with a particular chemical. The Data is presented in the format of a diamond. The left Blue



diamond represents Health Hazards, The top red diamond represents flammability properties, the right yellow diamond indicates reactivity properties. The bottom white diamond is for indicating specific hazards. The rating system is numbered from 0-4, where zero indicates the least amount of hazard and 4 indicates the most 4 indicates the most severe hazard associated with the chemical.

So, now you have the numbers, how do we interpret this for the safe handling of chemicals? Remember these are only guidelines; one must investigate each chemical for the specific hazards involved. One can use the Internet, MSDS, the manufacturers label. Reference books such as Genium's Handbook of Safety, Health and Environmental data, Prudent Practices in the Laboratory, CRC Handbook of Laboratory Safety, NIOSH pocket guide to chemical hazards for further detailed information on the safe handling of chemicals.

Blue: right diamond: Health Hazards:
0: No known health hazard have been identified, do not ingest
1: The chemical poses a slight toxic hazard, do not ingest or inhale. Handle with care. Can be an irritant to eyes/skin/ respiratory tract. Wash hands after handling

2: The health hazard is considered significant, but not life threatening, the chemical is considered toxic, do not ingest, may cause irritation to skin, eyes, respiratory tract. Handle with caution. May warrant the wearing of gloves and use of a fume hood. Wash hands after handling.
3: The health hazard is significant and can be life threatening. Use with extreme care, do not ingest or inhale, protect exposure routes by wearing gloves, use small amounts, dispense and use in a fume hood. Wash hands after handling.
4: This is a significant life threatening health hazard, deadly. Use with extreme care and respect. One must investigate what specific Personnel protection devices should be in place before handling the material. This warrants further detailed investigation before handling. Find a suitable less toxic substance if possible. Do not use.

Red: top diamond: Flammability Hazards:
0: the material will not burn
1: the material must be preheated in order to burn. Flashpoint above 200˚F.
2: Combustible: the chemical that ignite only when heated moderately. Flashpoint is above 100˚F, below 200˚F.
3: Flammable: the material will ignite spontaneously when exposed to ambient temperatures. Care must be taken in the method of choice when heating. Do not use a Bunsen burner. Use a fume hood to sweep away vapors so they don't ignite. Remove all sources of ignition. Keep tightly capped. Flashpoint below 100˚ F
4: Extremely Flammable: Materials rapidly vaporize. Use with extreme caution. . Care must be taken in the method of choice when heating this material. Do not use a Bunsen burner. Do not allow vapors to accumulate, use a fume hood. Remove all sources of ignition. Keep tightly capped. Flashpoint below 73˚F.

Yellow: Left diamond: Reactivity Hazards

0: The material is stable
1: A normally stable compound that can become unstable at elevated temperature and pressure.
2: An unstable material that reacts violently with water or will readily undergo violent chemical change but does not explode. Handle with care.
3: Unstable chemicals that react explosively with water, are capable of explosion when heated under confinement, or are sensitive to thermal and mechanical shock under confinement. Treat with respect and care.
4: These materials are readily capable of explosion at ambient temperature and pressure or from mechanical or localized thermal shock. Treat with respect and utmost care>

White: bottom diamond: Special Hazards. Here are a few examples of symbols you may see here. Again note that specific Precautions must be investigated for each individual chemical. Handle all these types of material with extreme care and use appropriate PPE (gloves, goggles, lab coats, fume hoods, shielding devices, when handling. Wash your hands after handling.

Oxidizer: Are highly reactive, readily release oxygen that supports combustion and often generates sufficient heat to produce spontaneous fires. Segregate from incompatible chemicals.

CORR: Corrosive If in contact will cause irreversible damage the skin and mucous membranes, respiratory tract by chemical action at the site of contact.

SENS: Upon repeated exposure, one can have an allergic reaction to the material
W: Water reactive materials react violently with water. Do not use around water.
Radioactive: This material is radioactive and requires specific and special handling.
Carcinogen: A substance or suspected substance that can promote or initiate cancer.
LACH: Lachrymator: A material that is a strong irritant to the eyes. Causes tears. Use in a fume hood.
IRR: Irritant A chemical that is not corrosive but causes a reversible inflammation of living tissue by chemical action at the site of contact. Protect against exposure
STENCH: A chemical with an offensive smell or stink. Use in a fume hood.

Chapter

9

Chapter 9 –Chemical Procurement

Orderly and consistent chemical procurement is the key to keeping track of what chemicals are stored in the building and making sure that the appropriate safety information is on hand.

Any faculty or staff member who needs a chemical should notify their department's designated person, who will order it, receive it properly, and notify the requestor when it arrives.

The chemical receiving process includes the following steps:

1. Checking the package on arrival for leaks or damage.
2. Marking the date received on each chemical container.
3. Checking to see if there is a Material Safety Data Sheet (MSDS) on hand for the chemical. If not, printing the supplier's MSDS from the Internet.
4. Determining if the chemical is already in the master chemical list. If not, determining hazard ratings and entering the information in the master chemical list.
5. Attaching appropriate hazard labels to each container.
6. If the chemical is new (not previously in the master chemical list), making sure that the person(s) who will be using it have reviewed a copy of the MSDS.
7. Entering MSDS information (manufacturer and date) in the master chemical list.
8. Filing the MSDS alphabetically in the department's collection. If there is already one there, keep the one that is the newest. If both are about the same age, keep the one from the manufacturer of the current shipment.
9. Determining the storage class, storage color and shelf location for each container.
10. Entering storage information for each container into the chemical inventory database.
11. Putting the container away in the proper storage location.
12. Marking the packing slip and giving it to the department secretary so that payment to the chemical vendor can be processed.

Chapter
10

Chapter 10 – Chemical Storage and Inventory Control

Adverse hazardous chemical reactions can occur when incompatible materials mix because of:

- ***accidental breakage,***
- ***container failure,***
- ***fires and earthquakes,***
- ***mixing of gases or vapors from poorly closed containers.***

Reaction products can include:

- ***heat or fire generation,***
- ***pressurization of containers; dispersal of materials or violent polymerization.***
- ***evolution of toxic or flammable gases,***

1. Keep chemical inventory to a minimum and do not store excess quantities of any hazardous materials.
2. Separate all chemicals according to compatibility groups (see below) and store them in labeled storage areas or cabinets.
3. Containers must be in good condition and compatible with their contents. Degraded, spilled or leaking containers must be disposed of as hazardous waste.
4. All containers must be legibly labeled with chemical name, concentration, and a hazard warning. Abbreviations and chemical formulae should not be used unless necessary, and then only if definitions are posted in the lab and other rooms where the container may be used or stored.
5. Extra labeling is required for high hazard materials requiring specific storage conditions – for example, peroxide formers and air or water reactives.
6. Chemicals must be dated when received. Peroxide formers and other chemicals that degrade over time must also be dated when opened.
7. Peroxide formers and other chemicals that degrade over time must be tested at least every 6 months (every 3 months is better) for the presence of organic peroxides. Any solvent that has accumulated more than 5 mg/L of peroxide should be disposed of promptly. (See Chapter 19 for more information on handling peroxide formers safely.)
8. Other chemicals that degrade over time should not be stored for more than one year.
9. Avoid storing excess quantities of flammable materials and use a flammable storage cabinet where necessary (see p. 32).
10. Do not keep flammable materials in a “domestic: or household refrigerator”, use a flammable storage refrigerator that is labeled as such.
11. Refrigerators used for food storage should be labeled with a “Store No Chemicals” label. Refrigerators used for storage of chemicals should be labeled with “Store no Food” label.
12. Each science department should maintain an accurate chemical inventory, updating it as chemicals are received, used up or disposed of. The inventory should include information on the storage class and designated storage location for each chemical container.
13. Excess chemicals may be able to be donated to others who can use them. See the Chemical Hygiene Officer for more information on this.

Whitworth Chemical Compatibility Storage Guidelines

Separate each of the following classes of chemicals from each other by storing in separate cabinets or on separate areas of shelving. Tubs and similar containers can also be used to provide separation. All containers should be clearly labeled, and all storage locations should be labeled according to compatibility group.

The following storage guidelines are adapted from the Washington State Department of Ecology's booklet, "Step-by-Step Guide to Better Laboratory Management Practices," March 1997.

1. **Color code chemicals by hazard type.**

   RED = flammability hazard; most stored in flammables cabinets

   RED STRIPE = flammability plus one or more other hazards

   YELLOW = reactivity hazard

   YELLOW STRIPE = reactivity plus one or more other hazards

   WHITE = corrosive hazard

   WHITE STRIPE = corrosivity plus one or more other hazards

   BLUE = toxic hazard

   GRAY = low-hazard or no hazard; general storage.

2. **Separate chemicals within their color according to the inorganic and organic classifications.**

   INORGANIC

   I-1A Metals, hydrides.

   I-1B Zinc, lithium, manganese, sodium, potassium, strontium.

   I-2A Halides, sulfates, sulfites, thiosulfates, selenites, phosphates, phosphites, phosphines, halogens.

   I-2C Sodium dithionite, sodium hydrosulfite.

   I-3A Amides, imides, imines, nitrites**, azides**, nitric acid.

   I-3B Nitrates** (except ammonium nitrate; isolate it!), Cadmium nitrate, mercuric or mercurous nitrate, nickel nitrate

   I-4A Oxides, silicates, stannates.

   I-4B Hydroxides, ammonium hydroxide, ammonia (liquid), Lye, Potassium Hydroxide

   I-5 Sulfides, selenides, phosphides, nitrides.

   I-6A Chlorates, perchlorates, perchloric acid, iodates, bromates, chlorites, hypochlorites, hydrogen peroxide.

   I-6B Peroxides** Sodium peroxide

   I-7A Arsenates, cyanates, antimonates, bismuthates, potassium thiocyanate.

   I-7B Cyanides.

   I-8 Borates, chromates, manganates, permanganates, vanadates, molybdates, tungstates, aluminates, perrhenates.

   I-9 Acids (except nitric).

   I-10A Sulfur, arsenic, phosphorus pentoxide**.

   I-10B Phosphorus** (red or white).

ORGANIC

O-1A Acids, amino acids, anhydrides, peracids.

O-1B Acetic anhydride.

O-2 Alcohols, glycols, amines, amides, imines, imides, sugars.

O-3A Hydrocarbons, esters, carbonates, aldehydes, oils. naphthalene

O-3B Benzene, methyl methacrylate.

O-4 Ethers**, ketones, ketenes, halogenated hydrocarbons, ethylene oxide.

O-5 Epoxy compounds, isocyanates.

O-6 Peroxides, hydroperoxides, azides**, benzoyl peroxide.

O-7 Sulfides, polysulfides, sulfoxides, nitriles, thiols, carbides.

O-8 Phenols, cresols.

O-9 Dyes, stains, indicators

O-10 Biological materials, waxes, resins, gums, enzymes.

O-11 Hydrazines, hydrazides.

O-12 Controlled substances (store in locked cabinet).

O-13 Carbon, carbonyls.

O-14 Biological media preparations.

OTHER

CG-1 Compressed gases - inert.

CG-2 Compressed gases - flammable

CG-3 Compressed gases - toxic

CG-4 Compressed gases - reactive (oxidizers)

R-1 Radioactive materials

3. Store chemicals properly to avoid incompatibility hazards.

- Separate acids from bases. If possible, store them in corrosives cabinets
- Store cyanides on upper shelves so that any accidental acid spills cannot drip onto them.
- Keep oxidizers away from flammables and reducing agents.
- Store flammable and combustible materials in flammables cabinets. Class III-B combustibles may be stored on open shelving. (See next page for flammability classes.)
- Store materials that are highly water-reactive (WR2 and WR3 in the "Hazardous Materials Classification Guide") in an area separate from other chemicals. Notify the Fire Department of where they are stored, and that water should not be used to fight a fire in that area.
- Store controlled substances (drugs & drug precursors) in the locked cabinet in Room 202 and limit access to them.
- Segregate gas cylinders by hazard type, and secure them to walls or benchtops with chains or straps. Store cylinders with valve covers securely screwed on.
- As much as possible, store chemicals at eye level and below. Avoid using high shelves unless absolutely necessary. Shelves must have a 1” lip.
- Do not store chemicals on floors, in fume hoods, or in ways that would block access to an emergency exit, eyewash or safety shower.
- Date containers when they arrive, and enter them into the chemical inventory system

Quantity Limits on Chemical Storage

Local fire and building codes limit the amount of hazardous chemicals that can be stored in buildings, depending on what the building is used for and the fire separation provisions in it. For the Science Building, the following limits apply. Questions about application of these limits should be directed to the Chemical Hygiene Officer (777-4339) and/or Spokane County Fire District 9, Fire Prevention Office (466-4602).

Flammable Liquids – Maximum Size of Containers

Container type	Class I-A*	Class I-B*	Class I-C*	Class II*	Class III*
Glass	1 pint**	1 quart**	1 gallon	1 gallon	5 gallons
Approved plastic	None	None†	None	None	5 gallons
Metal	1 gallon	5 gallons	5 gallons	5 gallons	5 gallons
Safety cans	2 gallons	5 gallons	5 gallons	5 gallons	5 gallons
Metal drums	60 gallons	60 gallons	60 gallons	60 gallons	60 gallons

*Class I-A – Flash point < 73 °F (22.78 °C), boiling point < 100 °F (37.78 °C);-Diethyl ether

Class I-B – Flash point < 73 °F (22.78 °C), boiling point ≥ 100 °F (37.78 °C);-ethanol

Class I-C – Flash point ≥ 73 °F (22.78 °C) and < 100 °F (37.78 °C);-2-butanol

Class II – Flash point ≥ 100 °F (37.8 °C) and < 140 °F (60 °C);1-pentane

Class III-A – Flash point ≥ 140 °F (60 °C) and < 200 °F (93.3 °C);-aniline

Class III-B – Flash point ≥ 200 °F (93.3 °C);-Adipoyl Chloride

** When ordering large quantities of a flammable liquid, ensure it is shipped in an approved storage container. Some examples of Class I-A and I-B liquids are:

I-A -- Acetaldehyde, ethyl ether, pentane, petroleum ether.

I-B -- Acetone, reagent alcohol, benzene, carbon disulfide, cyclohexane, 1,4-dioxane, ethanol, hexane, ligroine, methanol, propanol, tetrahydrofuran, toluene.

† There is an exception in the Fire Code for medicines, which includes rubbing alcohol (*70% iso*-propanol) in plastic one-pint containers as sold in drugstores.

Metal safety cans are the safest way to store flammable liquids. They have spring-loaded lids and an internal screen, which prevents combustion of the contents. Large polypropylene ("Nalgene") containers with stopcocks or valves at the bottom should never be used to store flammable liquids. These valves frequently leak and are unsafe in a fire.

Flammable Liquids – Maximum Quantities Per Control Area

There are four control areas in the Science Building, the maximum number allowed. Each floor is a control area and Room 202 is a separate control area. The "Hazardous Materials Classification Guide," a book written for firefighters, is the most convenient reference for determining the hazard classes for individual chemicals.

Hazard Class **Maximum quantity** (Reference is Article 80 of the uniform fire code)

Flammable liquids:

- I-A..... 30 gallons.
- I-B..... 120 gallons
- I-C..... 120 gallons
- Total I-A, B & C ..... 120 gallons

Combustible liquids:

- II ..... 120 gallons
- III-A..... 330 gallons
- III-B..... 13,200 gallons

Flammable gas..... 1000 cubic feet @NTP (28,300 liters)

Flammable solid ..... 125 pounds

Organic peroxides

- I ..... 5 pounds
- II,III,IV ..... 50, 125, unlimited pounds

Oxidizers

- 4 ..... 1 pound
- 3 ..... 10 pounds
- 2 ..... 250 pounds
- 1 ..... 4,000 pounds.

Oxidizing gas..... 1500 cubic feet @NTP (42,450 liters).

Pyrophoric..... 4 pounds

Unstable (reactive)

- 4 ..... 1 pound
- 3 ..... 10 pounds
- 2 ..... 250 pounds
- 1 ..... 4,000 pounds

Water reactive

- 3 ..... 5 pounds
- 2 ..... 50 pounds
- 1 ..... not limited

Toxic ..... 500 pounds

Highly toxic..... 10 pounds

Corrosive, irritant, sensitizer, carcinogens, other health hazards } 5,000 lbs.

Flammable Storage Refrigerators and Environmental Rooms

Never store flammable liquids in a standard or domestic refrigerator.

If flammable liquids must be refrigerated or cooled, they must be kept in an approved "flammable storage" refrigerator or freezer. There is one in the organic chemistry laboratory (Room 221), one in the upper division chemistry laboratory (Room 214) and one in the biochemistry research lab (Room 206).

Household refrigerators have a variety of ignition sources inside the cabinet, such as lights, switches, defrost coils, etc. that could ignite vapors. Flammable storage refrigerators have no ignition sources inside the cabinet. On extremely rare occasions, it may be necessary to use an explosion-proof refrigerator or freezer (i.e., one with no interior or exterior ignition sources). At present we do not have such a unit; however, the refrigerator in Room 221 is labeled and rated to be explosion-proof if it is connected to the building power via rigid conduit as described on the label on its back panel.

Environmental rooms (cold/warm rooms) have many ignition sources and little or no air circulation from outside. They should never be used for storage of flammable or other hazardous materials. Small quantities of hazardous materials (e.g. 500 ml) may be used in these spaces but they should not be stored there.

Chapter
11

Chapter 11 – Fume Hoods and Other Engineering Controls

Engineering controls (e.g., building ventilation, fume hood, etc.) are the most reliable way to protect worker safety in laboratories. All labs are provided with at least 11 air changes per hour (ACH) on the Chemistry floor and at least 6 ACH on the other two floors[1] to protect against brief or incidental exposures and to help control spills and releases. In addition, lab spaces should be negative in pressure relative to hallways and non-lab spaces to help control spills and keep vapors out of evacuation routes.

Laboratory processes that could create airborne hazards should be performed in a chemical fume hood. Chemical fume hoods are engineered and tested to be effective, and provide adequate protection for most processes – IF THEY ARE USED CORRECTLY.

Fume Hood Face velocity must be checked annually.

Types of Fume Hoods in the Science Building

First floor (Physics) -- 1 vertical-sash fume hood, Room 124.
1 exhaust snorkel in the auditorium.

Second floor (Chemistry) -- 9 vertical-sash fume hoods, Rms 203, 205, 206, 214, 221, 223 & 227.
22 benchtop ventilation stations, Rooms 214, 221 and 227.
2 exhaust snorkels, Rooms 204 and 223.

Third floor (Biology) -- 1 vertical-sash fume hoods, Room 309A
1 vertical-sash fume hood with auxiliary air supply, Room 320
1 Class II biological safety cabinet, Room 309
1 Class 1 biological safety cabinet-PCR Enclosure, Room 327

Guidelines for Fume Hood Use

- As a rule of thumb, materials with a TLV (exposure limit) of less than 50 ppm should be used in a hood.
- Do not open laboratory windows or use portable "breeze-box" fans in the laboratory. They cause drafts, which interfere with proper fume hood performance and can blow vapors from the laboratory into the hallway. If fume hoods are used properly, there should be no need for additional ventilation in non-emergency situations.
- The auxiliary air-supplied hood has two fan switches – one for exhaust and one for air supply. It will not work properly unless these are used as they are intended. Consult the manufacturer's instructions for details on how it should be used.

[1] Per Doug Kasman, ALSC Architects, the HVAC system installed during the building remodeling in 1998 is designed to provide a total of 22 ACH in laboratories on the 2nd floor and 12 ACH in laboratories on the 1st and 3rd floors. Only half this amount (11 ACH and 6 ACH respectively) is fresh outdoor air; the remainder is recirculated air.

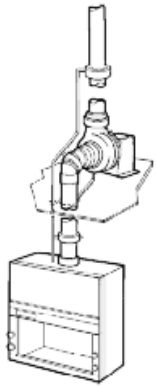
- Hoses and electrical cords should not be directed through the hood face opening, as they will interfere with closing the sash and are more likely to be accidentally snagged by persons working or walking in front of the hood. If hoses or cords must leave the hood, a small utility port should be provided in the side of the hood, with a cap to seal it when it is not in use. A utility port should be only large enough to allow plugs, etc. through, to prevent it from interfering with proper hood function.
- The biological safety cabinet (BSC) and the BSC-PCR enclosure must be inspected and certified annually, generally by an outside firm.
- The face velocity of all hoods (except the biological safety cabinet) is measured annually by the CHO. The opening (min of 18") that gives an average of 100 linear feet per minute (approximately 1 mph) is marked. This is the setting for routine use, hoods should only be raised above this level for set-up. Lowering the sash below this level may actually provide less protection due to excessive turbulence within the hood. Benchtop ventilation stations should be used with the sash lowered fully. For hoods to be most effective users must control traffic and cross drafts, which can easily overwhelm the face velocity.
- Work at least 6" inside the hood. Do not block slots at the back of the hood. For best distribution of airflow and capture of contaminants in the larger hoods, the bottom slot should be fully open and the top slot should be open 1 inch. Do not modify hoods by adding exhaust ducts or snorkels, these must be carefully engineered.
- Recognize hood limitations. See Guide to Engineering Controls below for more information.
- Proper hood use does not eliminate the need for proper personal protective equipment (i.e., lab coats, eye protection etc.) See Chapter 12 for more information.
- The biological safety cabinet has specified procedures for how long the fan must run before using the hood and after unloading the hood. Refer to the data labels on the front of the cabinet above the sash.
- The biological safety cabinet and the PCR hood have an ultraviolet light source inside, which can be damaging to both skin and eyes. Avoid looking at the tube or exposing otherwise skin or eyes to the ultraviolet light. See Chapter 26 regarding ultraviolet light hazards. *A sign reading* "Caution UV light may damage eyes" *will be posted on the cabinet*.
- A class II biological safety hood, when used properly, will protect the product, the person using it and the environment. A class 1 biological safety hood only protects the product.

Guide to Engineering Controls

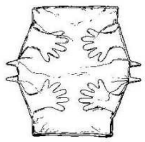
Fume hoods are effective protection for most lab workers for airborne hazards, as long as they are used properly (see guidelines, p. 35). There are other types of engineering controls available for specialized situations.

Wash Down Fume Hoods are required for work with heated perchloric acid. These are standard chemical fume hoods fitted with sprinklers to wash the ductwork work after perchloric use – this prevents explosive perchlorate crystals from forming. We do not have such a hood, and therefore work with heated perchloric acid is <u>not</u> allowed.

Flexible local exhaust systems are used in some labs. Referred to as "snorkels," these are used to exhaust gases and vapors from small areas or instruments. As with all engineering controls they must be tested annually to ensure they are performing properly.



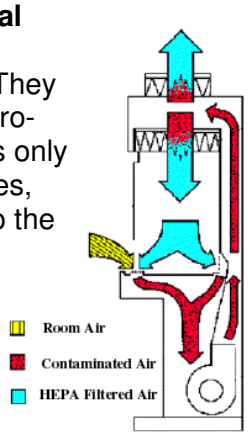
Washdown
Perchloric Hood



Four Hand Glove Bag

Rather than exhausting volatile substances with high acute toxicity, they may be contained in a **glove box,** airtight boxes with two or more heavy rubber gloves and an airlock. Glove boxes are also used for air and water sensitive compounds and to provide an inert atmosphere. **Glove bags** are a very economical alternative for short term uses.

Rather than exhausting contaminated air, or sealing it in a box or bag, **Biological Safety Cabinets** (BSCs) also called tissue culture hoods, use High Efficiency Particulate Air (HEPA) filters to remove particulate contamination from the air. They are primarily used to protect both personnel and product when working with micro-organisms by providing a particulate free work area (see diagram). HEPA filters only trap particles, so BSCs typically provide little protection against vapors and gases, unless the hood is designed to provide 100 percent exhaust and is connected to the building ventilation system.



Type II A Biosafety Cabinet

Chapter
12

Chapter 12 – Personal Protective Equipment

Engineering controls (Chapter 11) and work practices (Chapter 8) are the most important tools to protect lab workers from the hazards they face. However, the variable nature of lab work requires that proper personal protective equipment (PPE) be used at all times.

Choice of PPE depends on many factors, including whether other options are available to control exposure, the type of exposure, the toxicity of the chemicals used and the type of operation.

At a minimum all lab workers should have appropriate footwear, appropriate clothing and splash-resistant goggles whenever they handle any hazardous materials. Lab coats or aprons are recommended to protect street clothing. For many operations protective gloves will be required.

In all cases, adequate PPE that is in good condition must be available for all workers at all times, and in sizes which fit them correctly.

- **Protective Clothing** – When working with hazardous materials in a laboratory environment dress so that torso, legs, and feet are continuously covered and protected from spills and splashes. Lab coats or vinyl aprons are recommended when working with hazardous materials.
- **Eye Protection** - The State of Washington requires each institution of higher education to furnish eye protection devices free or at cost to all teachers and students engaged in activities potentially dangerous to the human eye at the institution, and on a loan basis to all visitors observing activities hazardous to the eye. Such devices must comply with the current revision of the ANSI Z87.1 standard.[2] In the Science Building this means that splash-resistant goggles are required for <u>everyone</u> wherever and whenever there is a potential for chemicals to be splashed into the eyes.

  Splash-resistant goggles are sold to students at the University bookstore. There are goggles available in each department for visitors to borrow. A face shield is available and should be used, along with goggles, when there is potential for explosions, implosions or a high splash hazard to protect the face and neck. Special goggles have been purchased for use with the lasers in the Chemistry and Physics Departments. These provide specific protection from the wavelength of laser for which they were purchased and should not be interchanged.
- **Respiratory Protection** - At this time, respirators **may <u>not</u>** be worn by employees in the science departments because Whitworth does not have a written respiratory protection program. The written program must include provisions (at Whitworth's expense) to make sure that the employee is medically able to use that respirator, and that the respirator is cleaned, stored, and maintained so that its use does not present a health hazard to the user. (See WAC 296-62, Part E, "Respiratory Protection", specifically section 296-62-07117.). An employee may voluntarily wear a “dust mask” defined as a tight fitting filtering face mask for protection against only nuisance dusts or vapors, the following documentation must be read, filled out and handed in to the CHO.

[2] Chapter 70.100 RCW.

Voluntary Respirator Use

Please read the following information in regards to the voluntary use of a "dust mask" respirator. Once you have read the information, Please sign a copy with Name, date and signature and hand into the CHO. Thank You.

Name_____
Signature_____
Date_____

Chapter 296-62-WAC, Part E
General Occupational Health Standards- Respiratory Protection

Figure 1 Important Information About Voluntary Use of Respirators

Note: "You" and "your" mean the employee in the following information.

Respirators protect against airborne contaminants when properly selected and worn. Respirator use is encouraged, even when exposure to contaminants are below the exposure limit(s), to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to you. Sometimes, workers may wear respirators to avoid exposures to hazards, even if the amount of hazardous contaminants (chemical biological) does not exceed the limits set by WISHA standards. If your employer provides respirators for your voluntary use, or if you are allowed to provide your own respirator, you need to take certain precautions to be sure that the respirator itself does not present a hazard.

You should do the following:

1. Read and follow all instructions provided by the manufacturer on use, maintenance, cleaning and care, and warnings regarding the respirators limitations.

2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupational Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is designed for and how much it will protect you.

3. Do not wear your respirator into atmospheres containing contaminants for which your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against solvent vapor or smoke (since smoke particles are much smaller than dust particles).

4. Keep track of your respirator so that you do not mistakenly use someone else's respirator.

Bottom of Form

- **Hand Protection** –

  Wear gloves whenever handling hazardous or toxic chemicals, substances of unknown toxicity, sharp-edged, very hot or very cold objects.

  Some general principles to follow for the selection and use of protective hand gear are:

  - Wear gloves of a material known to be resistant to permeation by the chemical in use. See the Glove Selection Guide below and data from the glove manufacturer for more information.
  - Inspect gloves for tears or holes before use. Replace gloves if permeation or degradation has occurred.
  - Wash gloves when they become contaminated to minimize contact and before removal.
  - Remove gloves before handling objects like doorknobs, pens, notebooks, keyboards.
  - Single use, disposable, Nitrile type gloves are adequate for incidental contact with most (but not all) hazardous materials. For non-incidental contact and gross contamination, heavy-duty gloves need to be selected for specific applications. See the Glove Selection Guide below and data from the glove manufacturer for more information or contact the Chemical Hygiene Officer at 777-4339.

Glove Selection Guide

Glove Use Guidelines

Latex gloves are widely used in labs. Unfortunately latex gloves offer little protection from commonly used chemicals and up to 20 percent of the population is allergic to latex products.

Latex gloves are only suitable for biological materials, nonhazardous chemicals, very dilute aqueous solutions of hazardous chemicals, clean area and medical or veterinary applications. In all cases single-use surgical-type **nitrile gloves** can be substituted. Nitrile gloves are more durable and provide a clear indication when they tear or break. Nitrile gloves also offer better resistance to most chemicals and are non-allergenic. Employees required to wear latex gloves should receive training on the potential health effects related to latex. If latex is required, hypo-allergenic, non-powdered gloves should be used.

Surgical-type (4 mil or 8 mil) gloves are suitable for "incidental contact." This means that no, or very little, actual contact with a chemical in use is anticipated. The gloves are there to prevent chemical contact with the skin where a spill or splash to the hand may occur. For "extended contact" a more substantial glove should be used.

Double gloving affords a double layer of protection. If the outer glove starts to degrade or tears, the inner glove offers protection until the gloves are removed and replaced. Best practice is to check the outer glove frequently, watching for signs of degradation (change of color, change of texture, etc.) and re-gloving as necessary.

For highly toxic materials and materials easily absorbed through the skin, **Norfoil** gloves (Silver Shield by North Hand Protection, 4H by Safety4, or New Barrier™ brand by Ansell Edmont) are generally recommended. They are somewhat bulky but dexterity is regained by using a heavier weight (8 mil) disposable nitrile glove over the Norfoil glove. These gloves and others are also available from many vendors.

For non incidental contact, start with **glove selection charts** provided by glove manufacturers. Different manufacturers use different formulations, and a glove from one firm may not have the same chemical resistance as a similar glove from another firm. Glove selection based on the manufacturers' glove selection charts is often impossible as only a limited range of chemicals have been tested for use with a specific manufacturer's glove. In particular, many research grade chemicals have not been tested by the various glove manufacturers.

If no compatibility information is available, or for any questions, contact the Chemical Hygiene Officer at 777-4339.

Chapter
13

Chapter 13 – Handling Chemical Emergencies

Follow Whitworth chemical storage guidelines (Chapter 10) to prevent/minimize spills, review emergency preparedness measures, (Chapter 2), post emergency telephone numbers at appropriate telephones, post emergency procedures (see boxes below) in each laboratory, and make sure everyone understands lab spill procedures.

All lab personnel should know:

- Where fire extinguishers are kept and how to use them - Chapter 3.
- The location, uses and limitations of the lab spill kit(s).
- The location of first aid supplies and how to respond to an injury - Chapter 1.
- Emergency procedures, including locations of eyewashes and safety showers.

For serious spills:

- Alert those in the area and evacuate while closing the doors behind you.
- Call the Chemical Hygiene Officer (777-4339) or Fire Department (9-911) for instructions.
- Keep personnel away from the area.

For incidental spills (small spills the lab staff is comfortable handling themselves)**:**

- Alert those in the area.
- Using protective equipment, use spill kit to contain the spilled material (see "Lab Scale Chemical Spill Kit") - kit should be tailored to the hazards found in the lab.
- Dispose of materials as chemical waste – see Chapter 14.

Prior to responding to any spill, lab workers should be thoroughly familiar with the hazards involved. This information should be included in the lab procedures or as a safety SOP. Lab workers should only handle small, incidental spills and should never handle a spill without understanding the risks to themselves and others.

If someone has been splashed:

- Use nearest eyewash, safety shower, or sink.
- Begin flushing immediately, continue for 10 – 15 minutes.
- Seek medical attention if necessary. Call 9 - 911 and request an ambulance if needed.

The first response for all chemical spills is to rinse the affected area with fresh water for at least 10 minutes (the exposed person will need assistance with this). If a shower is not available, wash hoses on many lab sinks can be used as a temporary substitute.

Eyewashes and Safety Showers

An emergency eyewash and safety shower must be available within 50 feet wherever there is a potential for substantial portions of the body to come into contact with corrosives, strong irritants, or toxic chemicals. These may be free standing units or eyewash units installed near lab sinks. Eyewashes must be activated weekly and inspected annually to ensure that they function correctly. Safety showers must be activated and inspected annually. (See WAC 296-62-130, part L, pg 35 "Emergency washing facilities.")

Maintain access to emergency eyewashes and safety showers at all times – Do not store anything around them that could impede access.

Eyewash/ safety shower units are located in the following lab rooms:
Physics: eyewash-room 114 and 134, shower-room 132.
Chemistry: eyewash/shower stations- room 202 (1), room 203 (1), room 214 (2), room 221 (2) and room 227 (2), portable eyewash bottle-room 204.
Biology: eyewash-room 304, room 309, room 319, room 320, room 330
eyewash/shower station-room 325,
portable eyewash bottles-room 304, room 321, room 323, room 327

Portable Eyewash Bottles
Sealed portable eyewash bottles may be used to provide an initial flush of the eyes. They should be immediately followed by use of a plumbed eyewash for at least 10 minutes, as the bottle does not contain enough liquid to flush the eyes for very long, and can only be used on one eye at a time. All portable eyewash bottles must be inspected monthly and replaced after the manufacturer's expiration date.

Lab Scale Chemical Spill Kits

Spills can occur wherever chemicals are used. Lab personnel can clean up small, incidental spills of hazardous chemicals if they feel comfortable doing so, and if they have the proper equipment.

Prior to responding to any spill, lab workers should be thoroughly familiar with the hazards involved. This information should be included in the lab procedures or as a safety SOP. Lab workers should only handle small, incidental spills and should never handle a spill without understanding the risks to themselves and others.

Laboratory personnel should not clean up spills that present an immediate life threatening hazard such as: fire, explosion, chemical exposure due to high volatility or highly toxicity (LD50 of 50 mg or less), easily aerosolized dust, has an overwhelming stench, or is a biohazard , etc.

Spills of large (>liter) highly volatile liquids not only are a fire hazard but may affect your health due to overexposure. Don't risk your health, if in doubt call 9-911 and ask for the hazardous materials team.

Mercury – Small spills (such as from a broken thermometer) can be effectively cleaned up by using the mercury spill kits in accordance with the instructions. However, vacuum gauges and some other equipment contain a large amount of liquid mercury – too much to be effectively cleaned up with the small spill kits that are available. In the event of a large mercury spill, turn on all available ventilation systems, contain the mercury as much as possible with sand or other inert material, and evacuate the area. Call 9-911 and ask for a hazardous materials team to respond.

All laboratory and research labs should be supplied with a spill kit. Employees who choose to clean up a spill must wear the proper personal protective equipment and wastes must be disposed of according to the guidelines in Chapter 14.

Suggested "kits" for handling spills are:

- **A container of Sodium bicarbonate for neutralization acid/base type spills.**
- **A mercury spill cleanup kit.**
- **A storage container labeled "Spill Kit" with the following items:**
  - **PPE – A pair of nitrile gloves. If the spill is not compatible with nitrile gloves, Silvershield gloves are available in the stockroom.**
  - **Universal spill absorbent pads. Additional pads are available from the stockroom.**
  - **Several ZipLock bags with blank Dangerous Waste labels attached.**

Chapter
14

Chapter 14 – Disposing of Hazardous Wastes

Chemical Hazardous Wastes

Chemical Waste is regulated by the Washington Department of Ecology (WDOE) and EPA (Environmental Protection Agency).

All materials, whether **Flammable, Corrosive**, **Reactive** or **Toxic** must be disposed of through the Whitworth Hazardous Waste Management Program.

The Chemical Hygiene Officer is responsible for deciding what is hazardous waste and what can go down the drain. **Faculty and students must never put any hazardous (or even potentially hazardous) materials down the drain without explicit permission from the Chemical Hygiene Officer**.

Please contact the Chemical Hygiene Officer (777-4339) for hazardous waste questions.

General Requirements

To be done in the laboratory:

- Designate and label a specific place or places in each laboratory for waste collection.
- Place all waste containers in adequate secondary containment (dishpans, etc.).
- Store all waste in compatible, adequately sized containers. Containers must be leak-proof, free of exterior contamination, and have at least 1 inch of headspace inside above the contents.
- Label containers as Dangerous Waste. Labels must indicate the contents of the container (full chemical names, not abbreviations) and its hazard type(s) and the date. The CHO has labels available for your use.
- Laboratories are considered “satellite accumulation areas”. This means waste cannot be stored in these areas. Once a container is filled or you’re done using it, notify CHO and place container in room 203, in secondary containment, on wooden shelf labeled “Hazardous waste to be processed”.

To be done by CHO:

- The waste must be weighed, and then logged in.
- All waste must be kept track of “from cradle to grave”.
- The waste will be stored in the designated waste storage area in room 202.
- Segregate chemical waste by hazard class and follow storage procedures in Chapter 10.

Generator Status

Whitworth strives to maintain Small Quantity Generator (SQG) status, to minimize legal requirements that must be met. These are contained in the Dangerous Waste Regulations, WAC 173-303, and enforced by the WA Department of Ecology.

SQGs may not generate more than 220 pounds of Dangerous Waste per month, of which not more than 2.2 pounds may be Extremely Hazardous Waste. Waste is counted as “generated” as

soon as it is waste, or for satellite accumulation in the labs, when the container is taken to a waste storage area. Waste generation is different from waste disposal.
SQGs may accumulate up to 2,200 pounds of Dangerous Waste, but still only 2.2 pounds of Extremely Hazardous Waste, before disposing of it.

- There is a time limit for waste storage if we go over these amounts.
- Hazardous wastes may not be kept for more than 90 days after generation if we are considered a large quantity generator (LQG), 180 days if we are a medium quantity generator (MQG) and unlimited time if we remain a Small Quantity Generator.

Exceeding the 220 pound generation limit in a month would make the campus a Medium Quantity Generator. Exceeding the 2.2 pound generation limit or either the 2,200 pound or the 2.2 pound accumulation limits at any time would make the campus a Large Quantity Generator.

Dangerous Wastes consist of:

- Discarded chemical products on the "U" list, WAC 173-303-9903.
- Wastes from sources on the "K" list, WAC 173-303-9904.
- Most wastes from sources on the "F" list, WAC 173-303-9904.
- Wastes having the characteristic of ignitability, corrosivity, reactivity or toxicity as described in WAC 173-303-090.
- Wastes with an equivalent concentration of toxic materials that is between 0.001% and 1%, as described in WAC 173-303-100(a).
- Wastes containing 0.01% to 1% halogenated organic compounds[3], as described in WAC 173-303-100(b).

Extremely Hazardous Wastes consist of :

- Discarded chemical products on the "P" list, WAC 173-303-9903.
- Wastes from sources shown as F020, F021, F022, F023, F026 or F027 on the "F" list, WAC 173-303-9904.
- Wastes with an equivalent concentration of toxic materials that is 1% or more, as described in WAC 173-303-100(a).
- Wastes containing more than 1% halogenated organic compounds, as described in WAC 173-303-100(b).
- Wastes containing more than 1% polycyclic aromatic hydrocarbons[4], as described in WAC 173-303-100(b).

[3] Halogenated organic compounds are defined as "*any* organic compounds which include one or more atoms of fluorine, chlorine, bromine or iodine which is/are bonded directly to a carbon atom" (emphasis added). WAC 173-303-040.

[4] Polycyclic aromatic hydrocarbons are defined as acehaphthene, acenaphthylene, fluorene, anthracene, fluoranthene, phenanthrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, pyrene, chrysene, benzo(a)pyrene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, benzo(g,h,I)perylene, dibenzo[(a,e), (a,h), (a,i) and (a,l)]pyrenes, and dibenzo(a,j)acridine. WAC 173-303-040.

Please consider what hazardous wastes will be generated as you are planning your experiments. This could impact our generator status. Please discuss your experiments ahead of time with the BLC (Biology Lab Coordinator) and/or the CHO (Chemical Hygiene Officer) to coordinate waste reduction ideas.

Detailed Chemical Hazardous Waste Procedures

Detailed procedures for generating, treating and disposing of chemical hazardous wastes are shown in Appendices E, F and G.

Other Types of Hazardous Wastes

Sharps

- "Sharps" – items capable of puncturing a trash bag – need to handled carefully to prevent injury to lab workers, custodians and other personnel. If clean, they can be placed in designated "broken glass" boxes. If contaminated with chemicals, they should be placed in a puncture-proof container (such as a glass jar), properly labeled, and placed in the waste storage area. Hypodermic needles should be disposed of in a designated Sharps container.

Infectious Wastes

See "Disposal of Biological Waste", Chapter 25, for guidance on disposal of infectious wastes.

Radioactive Wastes

It is extremely expensive to dispose of radioactive wastes (multiple thousands of dollars per shipment). Following a disposal in early 2000, the science departments do not anticipate generating any more. However, the Chemistry Department does still own several bottles of radioactive reagents. In the event that radioactive waste must be generated:

- Avoid creating radioactive waste that is also hazardous for other reasons (e.g., flammable, oxidizing, corrosive). These are called "mixed wastes" and are much more difficult and expensive to dispose of than plain radioactive wastes. Note that nitrates are oxidizers, so for instance, thorium nitrate waste is a mixed waste.
- Store all waste in compatible, adequately sized containers with adequate secondary containment (dishpans, etc.). Containers must be leakproof, free of exterior contamination, and have at least 1 inch of headspace inside above the contents.
- Label containers with Dangerous Waste labels (from the CHO), completely filled out. Labels must indicate the contents of the container (full chemical names, not abbreviations) and its hazard type(s).
- Notify the CHO if you have radioactive wastes for disposal.
- Radioactive wastes are kept in the Physics Department's locked wall vaults in Room 137. There is no time limit for disposal, but there is a limit to how much radioactive material Whitworth can own at any given time.

Recycling Hazardous Materials

Some wastes can be recycled, and therefore do not have to be counted as hazardous wastes:

- Mercury can be sent to a mercury recycling firm.
- Solvents which are not excessively contaminated can sometimes be distilled and used again. In this case, the residue (still bottoms) left after distillation count as hazardous waste.
- Rechargeable nickel-cadmium batteries can be recycled at some hardware stores.
- Some waste oils can be recycled through the campus waste oil program. Consult the Environmental Health and Safety Office (EH&S) regarding whether a specific oil can be recycled through this program.

Sometimes chemicals (generally unused, unopened containers) can be recycled through the Industrial Materials Exchange (IMEX) program operated by King County, Washington. Check their website at http://www.metrokc.gov/hazwaste/imex/index.htm for current listings of materials wanted and materials available. If chemicals are recycled in this manner, the receiving party must be a legitimate business and a liability waiver form should be completed and signed by both parties. See the Chemical Hygiene Officer (777-4339) for more information and waiver forms.

Chapter
15

Chapter 15 –Carcinogens and Reproductive Toxins

For purposes of this plan, a **carcinogen** is any chemical which:

- Is regulated as a carcinogen by WISHA; or
- Is listed in the category "known to be carcinogens" in the latest National Toxicity Program (NTP) Report on Carcinogens (http://ntp-server.niehs.nih.gov/Main_pages/NTP_8RoC_pg.html); or
- Is listed in Group I, "carcinogenic to humans," in the latest edition of the International Agency for Registration of Carcinogens (IARC) monographs (http://193.51.164.11/); or
- Is listed in Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogenic" by NTP and causes statistically significant tumor incidence in experimental animals as described in WAC 296-62-40003(25)(d).

A list of carcinogens meeting the first three of these criteria is in Appendix G.

For purposes of this plan, a **reproductive toxin** is any chemical which affects reproductive capabilities including chromosomal damage (mutations), effects on fetuses (teratogenesis), and effects on fertility. These are listed on the latest edition of the Proposition 65 list as a "chemical known to the State [of California] to cause reproductive toxicity" (http://www.oehha.org/prop65/899lsta.htm).

It is important to consider and eliminate unnecessary exposures to chemicals that may affect future health and reproductive ability, especially with young and inexperienced persons working in the laboratory environment.

Faculty may have a pressing need to use carcinogens or reproductive toxins in their research. In such a case, exposure must be prevented to the greatest extent possible:

- Information from the Material Safety Data Sheet and other lab safety resources about carcinogens should be used to develop protective measures, including engineering controls, work practices and PPE plus emergency practices and waste management. PPE procedures should include procedures to prevent spread of contamination, including removing any contaminated equipment (such as gloves) before leaving the designated area.
- All areas where carcinogens and reproductive toxins are used will be in restricted work areas, and all work surfaces and equipment used will be decontaminated by cleaning after use.
- As with all chemicals, workers have a right to medical attention if they are exposed. Report all exposures immediately for medical evaluation.

Chemical inventories should indicate all carcinogens and reproductive toxins, which should be kept in secure storage areas. Containers of carcinogens should be marked with a "cancer hazard" sticker, available from the Chemical Hygiene Officer.

Chapter
16

Chapter 16 – Controlled Substances

The use of psychotropic drugs such as narcotics for research purposes is regulated by the Federal government and requires special licensure. These chemicals are classified as Schedule I – V Controlled Substances or as "Listed Chemicals" which generally are drug precursors. Schedule I-V listings can be found at 21 CFR 1308.11 through 1308.15. Listed Chemicals are described in 29 CFR 1310.02.

Restricted Access
Access to controlled substances must be restricted to specific personnel who will be using these materials. Controlled substances cannot be stored in a cabinet with other, general use chemicals, even if it locks.

Storage Requirements for controlled substances are:

- The cabinet shall remain locked at all times.
- The cabinet should be located inside an area to which access is strictly limited.
- Hinges shall be installed in such a manner as to prevent access to mounting screws or bolts or to the hinge pins when the door is closed.
- The combination or key to the controlled substances cabinet shall at all times remain in the physical custody of the individual authorized by the Department Chair to maintain a storage cabinet for controlled substances. When users share a storage cabinet, responsibility for the key is given to the authorized individual in possession of the storage cabinet.

Inventory and Disposal

- Departments must maintain an accurate inventory of all controlled substance and listed chemicals.
- Inventories of controlled substances and listed chemicals should be checked at least quarterly to ensure that security measures are adequate.
- Persons wishing to dispose of controlled substances should contact the local Drug Enforcement Administration office (353-2964) to get authorization and disposal instructions. See 21 CFR 1307.21 for more information.

Chapter
17

Chapter 17 – Highly Toxic Chemicals

All substances can be toxic, depending on the dose. Special consideration should be given to work with materials that are toxic at very low doses. The table below gives an idea of how to view materials, depending on different measures of acute (short-term) toxicity.[5]

Toxicity Rating	Oral LD_{50} – Rat	Skin LD_{50} – Rabbit	Inhalation LC_{50} – Rat		Submersion LC_{50} - Fish
Highly toxic	<50 mg/kg	<200 mg/kg	<200 ppm, 1 hr	<2,000 mg/m^3, 1 hr	< 1 mg/L
Moderately Toxic	50 – 500 mg/kg	200 –1,000 mg/kg	200 – 2,000 ppm, 1 hr	2,000 – 20,000 mg/m^3, 1 hr	1 -- <10 mg/L
Slightly Toxic	500 – 5,000 mg/kg	1,000 – 5,000 mg/kg	2,000 – 20,000 ppm, 1 hr	20,000 – 200,000 mg/m^3, 1 hr	10 – 100 mg/L

As with all materials, the basic chemical safety guidelines in Chapter 8 should be followed. However, for acutely hazardous materials special consideration should be given to the establishment of a "Designated Area", containment devices such as hoods and glove boxes, and decontamination procedures. All waste should be handled according to Whitworth procedures outlined in Chapter 14.

Refer to the Material Safety Data Sheets and the Registry of Toxic Effects of Chemical Substances (RTECS) for information on toxicity of different materials. Chapter 3 of "Prudent Practices in the Laboratory" also has a great deal of useful information for evaluating potential hazards. Use information from these resources to develop safe work practices. These should include engineering controls (such as fume hoods, glove boxes or biosafety cabinets), safe work procedures and personal protective equipment (such as protective clothing, gloves and eye protection). All procedures should be included into written lab procedures or as separate safety SOPs, so they will not have to be re-developed each time the chemical is used.

Guidelines for work with substances of high acute toxicity should include:

- Prior approval or training before beginning work.
- Specific areas where work should be performed.
- Storage and labeling practices, including secondary containment.
- Use of engineering controls such as a fume hood or a glove box. As a rule of thumb, materials with a TLV (exposure limit) of less than 50-ppm should be used in a hood.
- How to respond to small spills and how to evacuate in case of large ones
- How to handle wastes.

Contact the Chemical Safety Officer (777-4339) for assistance.

[5] Adapted from Prudent Practices in the Laboratory, 1995, and WA Hazardous Waste Rules.

Chapter
18

Chapter 18 – Exposure Monitoring

Several sections of the WISHA (worker health and safety codes) require monitoring of employee exposure to various chemicals. Exposure monitoring may also be prudent for other chemicals if there appears to be a possibility of overexposure.

Exposure Limits

Chemical exposure limits are established by several organizations, generally for airborne (inhalation) exposures, as follows:

- Permissible Exposure Limit (**PEL**) – legal limit established by WISHA, and listed in WAC 296-62 Sections G, H and I. Updated only by formal legislative action, and not often.
- Threshold Limit Values (**TLV**) – recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). Updated annually, and listed in a small booklet they publish.
- Recommended Exposure Limits (**REL**) – recommended by the National Institute for Occupational Safety and Health (NIOSH). Updated periodically, and published in the NIOSH Pocket Guide to Chemical Hazards (current version available at http://www.cdc.gov/niosh/npg/npg.html.

Prudent practice dictates using the most protective standards; therefore, Whitworth strives to maintain all exposures below whichever of the three above limits is lowest.

Three different types of exposure limits are developed by each of the three above organizations, depending on the type of exposure being monitored.

TWA exposure limits apply to 8-hour time-weighted average exposures – the amount of exposure is averaged over an 8-hour work shift. These limits aren't very applicable to Whitworth laboratory exposures, which are generally of much shorter duration than 8 hours, and don't usually occur on a day-to-day basis. However, if there is only a TWA exposure limit set for particular chemical, then that is the exposure limit we must use.

STEL exposure limits apply to 15-minute time-weighted average exposures. Whitworth laboratory exposures should usually be compared to the Short-Term Exposure Limit (**STEL**) when one is established for the chemical being monitored. If there is no STEL established, standard practice is to use 3 times the 8-hour limit as a working short-term exposure limit.

Ceiling limits designate exposure concentrations that should not be exceeded at any time.

Exposure Monitoring Methods

Sampling methods for various air contaminants are established by both NIOSH and OSHA. They are available on-line at: http://www.cdc.gov/niosh/nmam/nmampub.html and http://www.osha-slc.gov/OCIS/toc_chemsamp.html respectively.

Procedures for taking air samples are available on-line in the OSHA Technical Manual, at http://www.osha-slc.gov/dts/osta/otm/otm_ii/otm_ii_1.html.

The Chemical Hygiene Officer is responsible for determining when exposure monitoring is appropriate. Either conduct it or have it conducted by an outside party. Keep records of the results, and communicate them to affected employees.

Required Exposure Monitoring

WAC 296-841-300 defines Occupational Exposure as the contact an employee has with a toxic substance, harmful physical agent or oxygen deficient condition. Exposure can occur through various routes of entry, such as inhalation, ingestion, skin contact, or skin absorption.

WISHA standards mandate exposure monitoring for the following chemicals if there is any occupational exposure:

Vinyl chloride	WAC 296-62-07329
Acrylonitrile	WAC 296-62-07336
1,2-Dibromo-3-chloropropane	WAC 296-62-07342
Inorganic arsenic	WAC 296-62-07347
Ethylene oxide	WAC 296-62-07355
Cadmium	WAC 296-62-07407
Lead	WAC 296-62-07521
Benzene	WAC 296-62-07523
Formaldehyde	WAC 296-62-07540
Methylenedianiline	WAC 296-62-07609

Other chemicals for which there are exposure limits should be monitored if there is reason to suspect that exposures might exceed the limits. This is particularly true if the chemical has a very low exposure limit.

Odor thresholds are very different from exposure limits, and often chemicals cannot be smelled until exposures are far above the safe exposure limits. Odor thresholds are listed in the Genium Handbook of Safety, Health and Environmental Data in the Whitworth Science Library.

Sample Analysis

The University of Washington's Department of Environmental Health maintains a laboratory certified by the American Industrial Hygiene Association for analysis of metals, silica, and organic solvents. They are also capable of analyzing SKC passive sampling badges.

They will analyze Whitworth samples at no charge (we pay the cost of shipping the samples to Seattle).

Contact person: Dr. Michael Yost
University of Washington
Department of Environmental Health
Health Sciences Bldg., F-461-C *for US mail only, PO Box 357234

Seattle, WA 98195
(206) 685-7243

e-mail: airion@u.washington.edu
Fax: (206) 616-2687

Outside Assistance

Since Whitworth's sampling capability is limited, it may be necessary to enlist outside help to complete large sampling tasks or tasks we are not equipped to do. Help is available at no charge from:

- The University of Washington's Department of Environmental Health has industrial hygienists that will assist Whitworth if needed. Contact the University of Washington Department of Environmental Health for more information.
- The WA Dept. of Labor and Industries operates a WISHA consultation program from their Spokane office. On-site assistance is available, and areas of non-compliance with the WISHA standards can be identified without the risk of citations and fines (unless severe hazards are identified and then not corrected). Contact industrial hygienists Karen Stout-Abariotes (324-2547) or Linda Anyan Brown (324-2539) for more information.

Chapter
19

Chapter 19 - Peroxide Formers and Other Potential Explosives

Certain solvents and other chemicals are known to form potentially explosive peroxides. Many of these are organic solvents; some are inorganic solids. An inhibitor is added to most peroxide-forming solvents by the manufacturer; this is usually effective until the container is first opened. After that, the inhibitor begins to be depleted. It can also become depleted during long storage without opening. High-purity solvents (e.g., HPLC grade) sometimes have no inhibitor added.

Common peroxide-forming compounds can be divided into the following groups:

- Ethers, including open chain and cyclic ether, acetals and ketals (e.g., ethyl ether, isopropyl ether).
- Hydrocarbons with allylic, benzylic or propargylic hydrogen (e.g., cumene, cyclohexene).
- Conjugated dienes, eneynes and diynes (e.g., butadiene).
- Potassium metal

The development of peroxides is usually a function of one of the following factors:

- Oxygen -- Oxygen is a necessary ingredient for peroxide formation. A cap left off a container or not tightly sealed may provide sufficient oxygen to support peroxide formation by eliminating the inhibitor and supporting initiation of the autooxidation process.

- Light -- Light sources, including sunlight, promote the autooxidation process along with the elimination of the inhibitor. Light, however, can only promote the autooxidation process if there is sufficient oxygen in the container. Once formed, peroxides have, in strong sunlight, spontaneously detonated with destructive results.

- Storage time -- Storage time simply gives peroxides time to develop and form structures. Since autooxidation is a self-sustaining reaction, the peroxide formation process increases along with an increase in the hazards.

Peroxide structures present a real explosive hazard. If they are present in a solvent, the hazard is compounded by the presence of a flammable liquid along with the explosive substance.
Peroxides are shock sensitive compounds that can explode if subjected to mechanical shock, intense light, rapid changes in temperature, heat, friction, or in some cases, by spontaneous reaction.

Checking For Peroxides

All containers of peroxide formers must be checked for peroxide formation at least every 6 months, and preferably every 3 months.

Visual Inspection

If the chemical is a solvent in a glass bottle, inspect the bottle visually before attempting to open it. Use a soft light source (flashlight) to light the interior of the bottle from the back or the side so you can get a good view of the liquid. Look at the entire inside of the container -- the bottom, the sidewalls, the portion above the contents, and the neck. Any hard crystal formations in the form of chips, ice-like structures, crystals, or solid masses; wisp-like structures floating in suspension or an obscure cloudiness are signs

that peroxide crystals may have formed. If it appears that crystals have formed anywhere, **DO NOT** unscrew the cap! Likewise, if the container has not been opened for many months, **DO NOT** unscrew the cap! If crystals have formed in the threads (due to solvent evaporating under the cap), the friction of opening it could cause an explosion. Any container of a peroxidizable solvent which shows any signs of crystal formation should be isolated to prevent its being moved or disturbed, and a qualified firm should be called to come and stabilize it for disposal. With proper management and routine testing of all peroxidizable solvents, this should rarely be necessary.

Solvents in metal cans cannot be visually inspected, and so it is very important to keep their lids sealed tightly and to check them every 3 months for peroxide accumulation. Non-inhibited solvents should not be purchased in metal cans.

If no crystal formation is visible, place the container of solvent in a fume hood. Wearing goggles, a face shield, heavy oven gloves and a heavy rubber apron, lower the sash as far as possible and carefully unscrew the lid. Test the contents by using peroxide test strips with a range of 0-25 mg/L peroxide, following the package instructions. If the strip indicates near 25 mg/L, retest the solvent by using peroxide test strips with a range of 0-100 mg/L.

Fill the container headspace with nitrogen before re-closing it, to discourage peroxide formation. Mark the test results and the date on the peroxide test label affixed to the container (see example below). If no label is present, apply one. The result should also be posted into the department's chemical inventory.

Peroxide Conc.	Date
_____	_____
_____	_____
_____	_____
_____	_____

If peroxide was detected at less than 5 mg/L, the container can go back into storage but should be used up as soon as possible. If it isn't likely to be used within the next 3 months, it should be disposed of.

If the result showed more than 5 mg/L of peroxide, the container should be stabilized, stored isolated and disposed of as soon as feasible. Consult with hazardous materials disposal reference books (available in the CHO office) for stabilization procedures. If the container results show more than 100 mg/L peroxide, one should consult with a firm that specializes in peroxide stabilization to determine if their expertise should be hired to safely handle and stabilize the container for disposal. Check with disposal firm to see if they will accept solvents whose testing results show peroxides are present.

Potassium Metal

Potassium metal is stored under oil or kerosene to exclude water and air. Visually inspect the chunks, looking for any whitish or yellow coating of potassium superoxide on the surface. The darker yellow this layer is, the higher the peroxide concentration. Disturbing the peroxide layer by cutting through it or trying to scrape it off can result in violent explosion. Any potassium metal with a yellow coating should be handled as hazardous waste -- see discussion above. Oxide-coated potassium sticks may need to be stabilized by a qualified firm before disposal.

Other Potential Explosives

Picric acid is relatively safe in the form in which it is sold. It is ordinarily sold with 10% water added to stabilize it. However, it can become explosive when it is allowed to dry out or when it forms certain metal salts. The following steps should be followed to safely store picric acid:

1. Never allow picric acid to be stored in containers with metal caps or to come in contact with any metal. Do not use a metal spatula to handle it!
2. Check the picric acid frequently to ensure that it remains damp. Add water if needed.
3. Wipe all crystals of picric acid off the threads and outside of the bottle with a damp paper towel after use, before sealing it back up.
4. Never try to open a bottle of old or very dry picric acid, or one that has visible dry crystals on the outside. Contact a qualified stabilization firm or the local bomb squad for disposal guidance.

Sodium azide, which presents an extremely high toxic risk, is not inherently unstable but may form highly explosive heavy metal azides if contaminated or used improperly. Disposal of sodium azide solutions to the sewer may cause the formation of lead or copper azide in plumbing pipes. Serious explosions can result. Care should also be taken that sodium azide is not heated rapidly or stored in containers with metal components (caps).

Perchlorates should be avoided insofar as possible. Perchlorate salts of organic, organometallic and inorganic cations are potentially explosive and can be set off by either heating or shock. Any metal perchlorate salts must be stored in containers that do not have metal components (caps). Contact of boiling undiluted perchloric acid or the hot vapor with organic matter or even easily oxidized inorganic matter will lead to serious explosions. This includes wood or other absorbent materials, which may become highly flammable after absorbing perchloric acid liquid or vapors. Perchloric acid evaporations must only be done in hoods connected to ductwork systems that have special wash-down provisions, and which are washed down after perchloric evaporations are done. (At present, Whitworth does not have such a system.)

Halogenated compounds such as chloroform, carbon tetrachloride, methylene chloride and other halogenated solvents should not be dried with sodium, potassium or other active metal; violent explosions usually result.

Other reactive or explosive hazards are described on pages 96-104 of "Prudent Practices in the Laboratory" and in Bretherick's "Handbook of Reactive Chemical Hazards." There is a copy of each of these available in the Chemical Hygiene Officer's office.

Chapter
20

Chapter 20 – Compressed and Hazardous Gases

Storage and Handling:

- Store cylinders in an upright position and in a well-ventilated area. Cap when not in use.
- Secure cylinders with at least one restraint, and preferably both upper and lower restraints. Laboratory cylinders less than 18" tall may be secured by stands or wall brackets.
- Different classes of gases (flammable, oxidizing, toxic, inert) should be stored separate from each other. In particular, oxygen and other oxidizing gases must be stored separately from flammable gases.
- Do not store cylinders in exits or egress routes.
- Cylinders and gas lines must be labeled. Do not depend on color codes.
- Do not roll, drag, slide containers, or lift cylinders by cylinder caps. Instead, use a hand truck or other suitable device.
- Always transport cylinders with cylinder caps in place.
- Do not attempt to repair a cylinder, valve or regulator.
- If a cylinder leak cannot be stopped by tightening the valve gland or packing nut, close the leaking valve, replace the valve cap and move the cylinder to a well ventilated area (i.e., outdoors). Notify the Chemical Hygiene Officer (777-4339) or campus security (777-3256) as soon as possible.
- Always use the correct regulator and never use adapters.
- Cylinders of flammable gases, such as hydrogen and acetylene, should have flashback protectors installed.

Maintenance and Refilling:

Whitworth owns the cylinders we currently have in stock. Therefore we pay no demurrage (rental) charges, but we are also responsible to maintain the cylinders in usable condition.

Gas cylinders must be hydrostatically tested periodically to ensure that they still meet the Department of Transportation strength requirements. Each time a cylinder is tested, the month and year are stamped into the upper shoulder. Retesting is due 5 years later. If the cylinder is also stamped with a five-pointed star immediately following the test date, the nest retest is not due until 10 years later. Cylinders do not have to be taken out of service as soon as the retesting date arrives, but they cannot be refilled after the retesting date until a new test is done. The cylinder may have to be transported out of town for testing, and it will have to be devalved, filled with water, dried, revalved and possibly cleaned (if it is for high-purity gas) before it can be refilled. Persons needed cylinders refilled should be aware of the time required, and plan accordingly.

Transportation:

If cylinders of compressed gases are transported over roads, they must have a safety cap on and be adequately secured so that they cannot move in the vehicle. One must follow all D.O.T. transportation regulations to transport gas cylinders. Contact CHO for more information.

Chapter
21

Chapter 21 - Operational Hazards

Many common pieces of laboratory equipment and common laboratory operations can cause severe injuries or damage if not used properly. The following topics are covered in this chapter:

- ❑ Centrifuges
- ❑ Ultra-Sonicators
- ❑ Distillation set-ups
- ❑ Water cooled equipment
- ❑ Vacuum pumps and systems
- ❑ Steam autoclaves
- ❑ Rotary evaporators
- ❑ Cleaning glassware
- ❑ Magnetic fields

Centrifuge Safety

1) Before using any centrifuge, review instructions in the owner's manual. Check rotor for rough spots, pitting & discoloration. Consult manufacturer if any are discovered.
2) High-speed rotor heads are prone to metal fatigue. Each rotor should be accompanied by its own logbook indicating the number of hours run at top or de-rated speeds. Do not exceed the design mass for the maximum speed of the rotor. Failure to observe this precaution can result in dangerous and expensive rotor disintegration.
3) Make sure rotor, tubes and spindle are dry and clean and that the rotor is properly seated and secured to the drive hub. Tubes must be properly balanced in rotor (½ gram at 1 G is roughly equivalent to 250 Kg @ 500,000 G's).
4) Ensure your samples are EQUALLY balanced. Use balance to check and compare weights: DO NOT eyeball! Specimen weights must match exactly! Samples must be equally spaced/blanced when placed in the rotor.
5) Before use, tubes should be checked for cracks. The inside of cups should be inspected for rough walls caused by erosion and adhering matter should be removed. Metal or plastic tubes (other than nitrocellulose) should be used whenever possible.
6) Use sealed rotors, sealed buckets, or a guard bowl with gasketed cover as well as safety centrifuge tubes (tube or bottle carrier with sealable cap or "O" gasketed cap).
7) After use, tubes, rotors, and centrifuge interiors must be cleaned and dried. If microbiological/bacterial agents were used, everything must be disinfected.
8) If a tube breaks, the centrifuge should be turned off, allowed to stand undisturbed for 15 minutes before opening. Clean and disinfect the rotor. If infectious material was placed in the centrifuge, plan proper decontamination and cleanup. Contact the Chemical Hygiene Officer at 777-4339 for advice on decontamination and cleanup.
9) Cleaning and disinfection of tubes, rotors and other components requires considerable care. No single method is suitable for all items, and the various manufacturers' recommendations must be followed to avoid rotor fatigue, distortion and corrosion.
10) Once run is complete, make sure the rotor has STOPPED before opening the centrifuge lid.

Safe Sonication

Ultra-sonicators use high frequency sound waves (16 – 100 kHz) for cell disruption and other purposes. This “ultrasound”, conducted through air, does not pose a direct hazard to humans, but the associated high volumes of audible sound can cause a variety of effects, including headache, nausea and tinnitus. Direct contact of the body with high intensity ultrasound (not medical imaging equipment) should be avoided.

Ultrasonic equipment in the lab should be enclosed in a 1” wooden box or a box lined with acoustically absorbing materials to reduce (mostly inaudible) emissions. Workers may choose to wear earmuffs or other hearing protection for their comfort. Contact the Chemical Hygiene Officer at 777-4339 for more information or an evaluation.

Quenching Stills

Quenching still bottoms -- reacting out metal drying agents -- is a potentially hazardous operation. It may be required because a distillation flask has become discolored and filled with a brown semi-solid. More commonly, it is required when a bottle of anhydrous solvent has been used up, leaving behind the strips of sodium that were placed in the bottle to dry the solvent.

This operation involves the use of flammable and corrosive materials. Personal protective equipment, including eye protection, gloves and protective clothing is required. See Chapter 12 for more information

This procedure must be conducted in a chemical fume hood, preferably with a heavy blast shield. (A blast shield has a lead-weighted bottom and clear bolt-on shield – it is not the lightweight type of shield sold for protection from beta radiation). Perform all operations in the hood; stand behind the blast shield and reach around to perform the manipulations required.

DO NOT perform this process ALONE! Have an informed, prepared person in the area who is familiar with spill and accident procedures. BEFORE conducting this operation get approval from the Chemical Hygiene Officer.

1. Decant unused solvent in a clean, empty fume hood. Pour it into a properly labeled bottle – either for storage or for disposal as waste. NOTE: If the still was neglected and there is a ball of metal surrounded by tar, use a high boiling inert solvent (e.g., xylene) to cover the drying agent and act as a heat sink.
2. If the drying agent is left in the bottom of a solvent bottle, use a high boiling inert solvent (e.g., xylene) to swirl and wash it out into a round-bottomed flask. It will also cover the drying agent and act as a heat sink. Do not try to react out the drying agent in the solvent bottle – it is not made of borosilicate glass, and may break during the process.
3. Place the flask into a bucket of ice water, secure it with a clamp and ring stand, and aim the mouth of the flask away from any people or equipment. Use a blast shield.
4. Pipette a small aliquot of 2- butanol. If gaseous bubbles appear, wait until they stop, then add another small aliquot of 2-butanol. Continue cautious step-wise addition until the generation of gaseous bubbles becomes very slow.

   If you wish to work with an added layer of safety, perform the entire quenching operation under argon or nitrogen gas.
5. After the 2-butanol, try adding an alcohol with more available protons, like 1-butanol. Continue cautious, step- wise addition until gas bubble generation slows. Continue the cautious addition with 2-propanol, ethanol, methanol and water, in that order.

   Be very careful with the addition of WATER! Even after methanol has been added, the drying agent can still react violently, especially is there has not been sufficient stirring of the solution.
6. Once the reaction with water is complete, pour this solution into a properly labeled waste container and dispose according to Whitworth chemical waste procedures, Chapter 14. To properly label the waste container with the percentages, you must keep track of the approximate amounts of the various solvents you used in this quenching process.

**** SPILL and ACCIDENT PROCEDURES ****

If anyone spills the unquenched flask, MOVE QUICKLY AWAY. The drying agent may spontaneously ignite in the air and the flammable solvent may cause a flash fire. Inform EVERYONE in the immediate area and have them move to safe location.

If the spill is large call 9-911 and inform emergency responders of the condition. There are two likely occurrences: (1) the flammable solvent will evaporate and the alkali metal or metal hydride will oxidize with the moisture in the air, or (2) the alkali metal or metal hydride will react vigorously with a proton source (like water) and will generate hydrogen gas, which may spontaneously ignite with the heat of the reaction. If this occurs, EXIT and CALL 9-911 and Campus Security (x3256), as the entire area may be quickly engulfed in flames.

If the spill is small, and doesn't contain any alkali metal or metal hydride, treat it as a flammable materials spill. Cover the spill with an absorbent pad then, once the spill is absorbed, place the pad in a bag, properly labeled with the contents for hazardous waste disposal.

If the spill evaporates completely and leaves the slowly oxidizing alkali metal or metal hydride behind, gather these carefully into a beaker and quench with the same previously described procedure.

Water-Cooled Equipment

The use of cooling water in laboratory condensers and other equipment is common laboratory practice, but can create a flooding hazard. The most common source of the problem is disconnection of the tubing supplying water to the condenser. Hoses can pop off under irregular flows when building water pressure fluctuates or can break when the hose material has deteriorated from long-term use. Floods also results when exit hoses jump out of the sink from a strong flow pulse or sink drains are blocked by an accumulation of extraneous material. To avoid such problems:

- Use hose clamps if necessary to keep hoses from popping off their connections.
- Use a metal ring clamp, fastened just tightly enough to hold the hose, to keep it from jumping out of the sink.
- Make sure that there are no rags, paper towels or other materials in the sink, which could block the drain.
- Be sure to turn off the water flow when leaving the setup. Do not leave water-cooled equipment running unattended.

Vacuum Pumps & Systems

Injury due to flying glass is often a possibility when using vacuum. Since the external pressure leading to implosion is always one atmosphere, the hazards are the same whether the vacuum is produced by a water aspirator, a vacuum pump, or a high-pressure vacuum system.

The Science Building has a piped vacuum system with 61 outlets on the second floor and one outlet in Room 309. The pump is located on the first floor, below the south stairwell. There is a cold vapor trap in Room 225, plumbed in-line to condense solvent vapors from the vacuum outlets in Rooms 221 and 223 (the organic chemistry labs).

There are also:

- Water aspirators, stored in the Chemistry stockroom.
- Portable vacuum pumps in the Chemistry and Physics departments.
- Mercury-filled pressure gauges to check vacuum levels in the Chemistry department.
- Rotary evaporators stored in the Chemistry department.

Glassware

Always inspect glassware to be used under vacuum before it is put into service. Do not use a piece of glassware that is chipped, cracked or even scratched, as it may implode unexpectedly. Always use heavy-duty glassware that was intended and designed to be used for vacuum operation.

Evacuated equipment such as Dewar flasks, vacuum dessicators, rotary evaporator flasks should be handled with care. In order to contain glass pieces in the event of implosion, encase the exterior with protective netting or apply electrical tape in a grid pattern. Diminish the chance of implosions by gradually increasing the rotation speed and vacuum applied to a flask on a rotary evaporator.

Pump Maintenance

Each vacuum pump should carry a tag indicating the date of the most recent oil change. Oil should be changed once a month when the pump is in regular use, or sooner if it is known that the oil has been exposed to reactive gases.

Belt-driven mechanical pump with exposed belts and/or spoked drive pulleys must have protective guards.

All pumps should be vented into a hood or to the outdoors well away from bystanders and air intakes. Scrubbers or absorbers are recommended when evacuating a system containing volatile toxic or corrosive substances. A scrubber or absorber can prevent the toxic or corrosive chemical from contaminating the pump oil and/or being discharged into the atmosphere. Contaminated pump oil, particularly if chlorine has been absorbed into it (such as by pumping hydrogen chloride gas) must be handled as hazardous waste. Waste oil containing chlorine should be labeled as to the source of the chlorine, because it will test positive on any routine screening test of waste oil for PCBs.

A cold trap should be used in line ahead of the pump to condense volatile vapors. A trap will also protect against from mercury being swept into the pump as a result of sudden loss of vacuum (such as if a pressure gauge were broken). In such an event mercury-contaminated pump oil, and possibly the pump itself, must be treated as hazardous waste.

Trapping Liquids and Vapors

Vapors and liquids pulled into a vacuum system do not just go away! Trap bottles should <u>always</u> be used to capture liquids before they can be pulled into the building vacuum system, into a vacuum pump or into the water stream from an aspirator.

Solvents should not be evaporated into a vacuum system unless there is a functioning cold trap in line ahead of the pump or aspirator to prevent damage to the pump seals and discharge of the solvent to the atmosphere.

The cold vapor trap in Room 225 operates by mechanical refrigeration. It must be turned on and allowed to reach an appropriately cold temperature before being used to trap solvent vapors. After use, the accumulated solvent should be drained off into an appropriately labeled bottle and treated as hazardous waste (see Chapter 14). After removal of the solvent, the cold vapor trap should be shut off until it is to be used again.

Mercury Spills

Vacuum gauges contain a large amount of liquid mercury – too much to be effectively cleaned up with the small spill kits that are available. In the event of a large mercury spill, turn on all available ventilation systems, contain the mercury as much as possible with sand or other inert material, and evacuate the area. Call 9-911 and ask for a hazardous materials team to respond.

Steam Autoclaves

The Biology department has a steam autoclave in Room 325 that is used for sterilizing various pieces of equipment as well as rendering infectious wastes non-infectious. For guidelines on using the autoclave to sterilize infectious waste, see Chapter 25. Following are general guidelines for autoclave use:

- Pyrex bottles, empty or full should have their caps placed on **loosely**, to prevent explosion due to expansion. Use tinfoil to cover non-safety-glass bottles (non-Pyrex).
- Always use some type of secondary containment, typically polypropylene or stainless steel tubs. This will eliminate the primary cause of damage to the machines and reduce down time.
- Always follow written lab procedures, however dry goods typically require about 30 minutes sterilization, plus about 20 minutes drying time (dry time may need to be increased for enclosed items such as pipette tips or bottles with lids).
- Average liquid sterilization times (add an additional 10-20 minutes for crowded items):
  <500 ml, 30 minutes **500 ml - 1 L**, 40 minutes **2 L - 4 L**, 55 minutes **4 L**, 1 hour
- **Not all plastics can be autoclaved.** Polypropylene and polycarbonate will survive; but polyethylene and high density polyethylene will not. The different types of plastic can be identified by looking for initials imprinted on the bottom of containers (PP=polypropylene, PC=polycarbonate, PE=polyethlylene, HDPE=high-density polyethylene). If you are unsure about a new container, place it in an autoclave safe container the first time.
- To prevent the bottoms of bottles from breaking place them in a tub with 1” – 2” of water.
- Autoclaving new glassware for 90 minutes will partially temper it, increasing its strength
- Use "slow exhaust" or “liquid cycle” or equivalent for liquids and let them stand for 10 minutes.
- Do not open any autoclave until the pressure gauge labeled "chamber" reads zero, stand back and allow steam to escape through the open door before reaching in to remove items.
- Never open an autoclave set for "slow exhaust" until the cycle is complete. Superheated liquids can boil over, possibly damaging both autoclave and autoclave operator. After the cycle is complete, let liquids stand 10 minutes more, movement could cause liquids to boil.
- Handle hot glassware with care, using dry, heat resistant gloves to remove items.

Magnetic Fields

The nuclear magnetic resonance (NMR) spectrometer in the Chemistry department contains a powerful supercooled magnet. If ferromagnetic objects (such as: keys, scissors, knives, wrenches, other tools, bookends, stepstools, compressed gas cylinders, cylinder carts, etc.) come too close to it, they can become projectiles. A hard bump on the exterior of the magnet, such as by an object crashing into it, can be enough to misalign components inside, cause uneven cooling, and lead to a magnet "quench." This is a BIG hazard -- see the discussion of quench hazards in Chapter 22.

Magnetic field strength increases by the seventh power as distance is reduced. Ferromagnetic objects may be scarcely affected beyond a certain distance, but at a slightly shorter distance may experience a significant attraction to the magnet. If the object is able to move still closer, the attractive force increases rapidly until the object becomes a projectile.

Therefore, all ferromagnetic objects must be excluded from within the 5-gauss[6] line around the magnet. This line extends in a 3-dimensional ovoid shape. Wearers of cardiac pacemakers, similar medical electronic devices and metal implants should also be kept outside the 5-gauss line. Because this is such an important exposure measure, and because magnetic field exposure cannot be felt, the 5-gauss line should be clearly marked at all times.

Gas cylinders and other massive portable ferromagnetic objects should be kept well away from the 5-gauss line, particularly when they are being moved, because they are (1) easily affected due to their metal mass and (2) easily movable. Movement of ferromagnetic objects will also affect the readings obtained by the spectrometer, and should not be done when an analysis is in progress.

Although not a safety issue per se, the magnetic field around the NMR can also adversely affect credit cards, ID cards, key cards, computer diskettes and other magnetic objects. Persons carrying such objects should leave them, as well as keys, pocketknives and other metal objects, in a designated place outside Room 204 before entering.

[6] Gauss is a measure of magnetic field strength. One Gauss is equal to 10^{-4} Tesla.

Chapter
22

Chapter 22 – Cryogenic Liquids

Cryogenic liquids (liquefied gases with temperatures below –73° C) and their boil-off vapors rapidly freeze human tissue and cause embrittlement of many common materials. Cryogenic liquids also produce large volumes of gas when they vaporize (700 gas:1 liquid for helium; 694:1 for nitrogen) and may create oxygen-deficient conditions.

Precautions for working with cryogenic liquids

- When transferring cryogenic liquids, use appropriate personal protective equipment. Along with wearing goggles, a face shield is recommended to protect the face and neck. Insulated gloves may be used, but can become hazardous if the cryogenic liquid enters a glove.
- Minimize boiling and splashing of cryogenic fluid during transfers to open cryogenic containers, such as Dewars. Follow all manufacturers' instructions during cryogen transfers.
- Avoid clothing that can trap spilled liquid. If skin contact with a cryogenic liquid occurs, do not rub skin. Instead, place the affected part of the body in a warm (not hot) water bath.
- Be alert for the condensation of oxygen from air. Liquid oxygen is extremely hazardous – may explode on contact with oxidizable materials.
- Use high quality Dewars with protective covers, not standard "thermos" bottles.
- Excessive ice buildup could result in the discharge of excessively cold gas or structural damage to the cryogenic container or surroundings.
- All cryogenic systems (including piping) must be equipped with pressure relief devices that are directed to a safe location.
- Hot air should be used to thaw frozen equipment. DO NOT USE water to thaw liquid helium equipment.
- **In the event of a NMR magnet "quench" or a large spill of cryogenic liquid, EVACUATE the room immediately and close the door.** **Call security (x4444)** and ask that they respond with an oxygen meter. **Do not allow** anyone into the room until it has been tested and shown to contain enough oxygen for safe entry (at least 19.5%).

Cryogenic Liquids in use:

Liquid	Storage Location	Use
Helium	Room 204	NMR magnet cooling
Nitrogen	Room 204	NMR magnet cooling (keeps the helium cool)

Chapter
23

Chapter 23 - Human Subjects

This chapter is included in this plan because it deals with the safety of human subjects of any research that may be conducted by faculty, staff or students in the science departments.

Whitworth is responsible for the protection of the rights and welfare of human subjects of research conducted by, or under the supervision of, faculty, staff or students. To administer this responsibility effectively, the University maintains an Institutional Review Board (IRB) to review research protocols involving human subjects and to evaluate both risk and protection against risk for those subjects.

Human subjects are defined as: "living individuals about whom an investigator (whether professional or student) obtains (1) data through intervention or interaction with the individuals or (2) identifiable private information, e.g. school transcripts."

The efforts of the IRB are directed at ensuring, among other things, that:

(a) Risks to the subjects are minimized.

(b) Risks to the subjects are reasonable in relation to anticipated benefits, if any, to the subjects, and the importance of the knowledge that may be reasonably expected to result.

Research investigators are responsible for obtaining each subject's informed consent to participate in the research and for ensuring that no human subjects will be involved in the research prior to obtaining their consent. Informed consent is the knowing consent of an individual or her/his legally authorized representative, obtained without undue inducement, force, fraud, or other forms of constraint or coercion. A consent form signed by the subject, is needed to document informed consent.

Studies involving secondary use of existing data, such as reviews of existing medical records, **exposure monitoring results**, vital statistic records or computer databases from previous studies **require human subjects approval** to ensure protection of subject confidentiality and privacy, although these studies may qualify for expedited review

The Whitworth IRB shall review all human subject research conducted by Whitworth faculty, staff or students, or that involves the use of Whitworth's non-public information to identify or contact human research subjects.

Reviewers are interested in the goals, design, study procedures, safety procedures, and qualifications of the investigators. Particular attention will be paid to the "Risk: Benefit Ratio" of the investigation and the adequacy of the Consent Form in conveying Human Subjects concerns.

Any questions regarding the necessity of Whitworth IRB review should be addressed to the director of Sponsored Programs in the Academic Affairs office (777-3701).

Chapter
24

Chapter 24 – Animal Use

Failure to comply with federal, state or University requirements for (1) protecting researchers, human subjects and the public during research and/or (2) ensuring the welfare of animals used in research is considered "misconduct in scientific and academic research" subject to investigation and institutional action by the University.

The Biology department has a collection of equipment for housing and handling rodents. Projects involving hazardous materials and/or animals likely to be carriers of zoonoses should be submitted to the Chemical Hygiene Officer for review and to map out any procedures necessary for carrying out research while minimizing risks.

Human Health Effects

Approximately 20% of all animal handlers develop allergies to animals and 70% of animal handlers with pre-existing allergies develop animal allergies. Wild and domestic rodents can also carry pathogens and diseases (zoonoses) that are transmissible to people including:[7]

Arenaviruses	*Blastocystis hominis*	*Borrelia burgdorferi*
Brugia species	*Campylobacter*	Colorado tick fever virus
Cryptosporidium species	*Francisella tularensis*	*Hymenolepis nana* and *diminuta*
Leishmania species	*Listeria monocytogenes*	*Pasteurella multocida*
Pneumocystis carinii	*Pseudomonas pseudomallei*	*Rickettsia* species
Salmonella species (nontyphoidal)	*Schistosoma* species	*Spirillum minor*
Streptobacillus moniliformis	Tick-borne encephalitis	*Trichinella spiralis*
Trypanosoma cruzi	Viral encephalitis	*Yersinia enterocolitica*
Yersinia pestis (plague)		

Persons directly involved in animal husbandry and those who work with rodents or wild animals are recommended to seek their physician's advice if they:

1) Have known or suspected allergies;
2) Have chronic health problems such as diabetes, serious renal or liver disease;
3) Have immune system problems;
4) Are on current therapy with high-dose steroids, radiation, or chemotherapy;
5) Have a history of spleen problems and/or
6) Might be pregnant.

[7] County of Los Angerest- department of Health Services, Veterinary Public Health and Rabies Control, "Overview of Zoonoses," at http://phps2.dhs.co.la.ca.us/vet/guides/vetzooman.htm, Table 4, "Zoonoses of Wildlife"and Table 5, "Zoonoses of Domestic Animals."

Chemical Hazards and Research Animals

Hazardous chemicals are used in and around animals for several purposes (e.g., sterilant/disinfectant, to study toxic response, to damage or emphasize a physiologic function, to anesthetize/euthanize, for chemotherapy, to create tumors, etc.). An assessment of the risks and the selection of appropriate work practices are necessary to conduct this work safely. Begin the risk assessment by identifying the chemicals to be used and the circumstances of use, and then use the resources listed in Chapter 8 to evaluate toxicity, routes of exposure, best procedures to minimize exposure and preparations for contingencies.

Animal physiology complicates risk assessment for projects involving hazardous chemicals. Some quantity of the hazardous material will be excreted (via feces, urine, breath, sweat, etc.) although the route, timing and quantity will vary depending upon the species, the chemical and other factors. Chemicals also may be biotransformed into substances with entirely different hazard characteristics. In addition, the administration of the chemical itself may have additional risk factors (e.g.: animal struggles, sneezes, bites, etc.) that could contribute to additional occupational exposures.

Before projects involving hazardous chemicals in animals are conducted they should be reviewed and approved by the Chemical Hygiene Officer. All potentially exposed people, including those involved in the research, those in close proximity, and animal care personnel must understand:

- the hazardous chemicals and byproducts,
- the hazards or toxic effects and symptoms of exposure,
- the routes of entry, and exposure,
- required personal protective equipment,
- required engineering controls (fume hood, glove box, etc.),
- waste disposal methods.
- emergency/spill measures.

Chapter
25

Chapter 25 –Blood-borne Pathogen Control and Basic Biosafety

Blood-borne Pathogen Control

Whitworth faculty, staff and student employees are not required to provide first aid or medical care as part of their job duties. However, exposure to human blood could occur while providing first aid on a "Good Samaritan" basis, or possibly in the course of work with blood *in vitro*.

A CPRotector and a pair of latex or nitrile gloves are provided in each first aid kit to minimize contact with blood or body fluids, as part of Whitworth's blood-borne pathogen control program. If an injured person is bleeding, gloves should be donned by anyone providing first aid, before starting to do so. If the bleeding is severe and/or spurting, goggles should also be worn to prevent exposure to the eyes. Prompt evaluation is important if a person has been exposed (by needle stick, splash, or direct contact) to human/primate blood or body fluids:

- First: wash the wound/ area thoroughly with soap and water.
- Then seek advice (treatment may also be included) from the appropriate medical facility listed in Chapter 1.

Spilled blood should be covered with a solution of one cup of liquid bleach (5.25% sodium hypochlorite) per gallon of water, and let stand for 5 minutes to disinfect it. The mixture can then be absorbed on spill pads, placed in a sealed labeled glass jar, and autoclaved as described under "Disposal of Biological Waste" in this chapter.

Universal Precautions

All human/primate blood and other potentially infectious body fluids, tissues and cells should be assumed to be infectious and should be handled with "universal precautions" to prevent infection with HIV, HBV or any other blood-borne pathogens.

"Universal precautions" include frequent handwashing, proper handling and disposal of contaminated needles, no eating, drinking, smoking or application of cosmetics or contact lenses in the lab, and no mouth pipetting. Food and drink must not be kept in the same refrigerator, shelves, countertops or benchtops where potentially infectious materials are stored or used.

Engineering controls (e.g., biosafety cabinets, ventilation, closed top centrifuge rotors, etc.) must be used to control exposures along with appropriate Personal Protective Equipment (e.g., gloves, lab coats, face shields, goggles).

See Chapters 11 and 12 for more information.

Basic Biosafety

This section covers work with all organisms (bacteria, chlamydia, fungi, parasites, prions, rickettsias, viruses, etc.) that can cause disease in humans, or cause significant environmental or agricultural impact. The program also covers work with human or primate tissues, recombinant DNA, transgenic plants or animals, human gene therapy, releases of recombinant DNA to the environment, and work with animals known to be reservoirs of zoonotic diseases. Bear in mind that a large number of organisms that would ordinarily be innocuous can be infective in immuno-compromised persons.

Determining the Appropriate Biosafety Level

Work with biological organisms or recombinant DNA (rDNA) is classified according to risk group and assigned a corresponding biosafety level. Biosafety level I (BSL I) is for organisms "not known to cause disease in healthy adults." This would include, for instance, most microbiology lab work with organisms not pathogenic to healthy adults. Biosafety Level I represents a basic level of containment that relies on standard microbiological practices with no special primary or secondary barriers recommended, other than a sink for handwashing. Practices appropriate for risk group I activities are outlined below.

Biosafety Level II (BSL II) is for organisms "associated with human disease, where the hazard is auto-inoculation, ingestion, or mucous membrane exposure."[8] Hepatitis B virus, *Salmonella* species and *Toxoplasma* species are representative of microorganisms assigned to this level. Work with recombinant DNA also generally falls into BSL II. Practices appropriate for risk group II activities are outlined below.

Risk group classifications for specific organisms can be found at:

- "Biosafety in the Microbiological and Biomedical Lab" http://www.orcbs.msu.edu/biological/BMBL/BMBL-1.htm from the Centers for Disease Control and Prevention (CDC).
- "Risk Group Classification for Infectious Organisms" http://www.absa.org/riskgroups/default.htm from the American Biosafety Association (ABSA).
- Biosafety MSDS collection at http://www.hc-sc.gc.ca/hpb/lcdc/biosafty/index.html.

Work with recombinant DNA (rDNA):

The National Institutes of Health (NIH) Guidelines for Research Involving Recombinant DNA Molecules (http://www.niehs.nih.gov/odhsb/biosafe/nih/rdna-apr98.pdf) outline requirements for experiments generating recombinant DNA (rDNA).

[8] "Biosafety in Microbiological and Biomedical Laboratories," U.S. Department of Health and Human Services, March 1993, HHS Publication No. (CDC) 93-8395.

Biosafety Level I (BSL-I) Practices

1. Always use standard lab Personal Protective Equipment (PPE) ; see Chapter 12.
2. Always work in standard lab facilities that have handwashing facilities and negative air pressure with respect to hallways and corridors.
3. Decontaminate work area daily and upon spills, using written decontamination and spill procedures (see Chapter 13).
4. Handle waste as biohazardous (see "Disposal of Biological Waste below) using double red bags in durable, closed, specially marked, leak-proof containers. Decontaminate biohazardous waste before disposal, preferably by autoclaving.
5. Public access while experiments are in process is not recommended. Minimize aerosol generation and use mechanical pipetting devices.
6. Eating, drinking, application of cosmetics or contact lenses are permitted only in designated clean areas.
7. Special containment equipment such as a biological safety cabinet is not required for BSL 1 work.

Biosafety Level II (BSL-II) Practices

BSL-I practices, plus:

1. Access to the laboratory while experiments are in process is limited
2. Biohazard sign must be posted on freezers and refrigerators holding BSL II materials. Biohazard signs indicating BSL II must be posted on doors of labs where BSL II materials are stored or used.
3. All aerosol-generating processes must be conducted inside a properly functioning Class II biological safety cabinet (BSC). The BSC work surface must be decontaminated after each use. Bench top work is permitted only for low-hazard procedures.
4. Decontaminate bench top work area daily and upon spills, using written decontamination and spill procedures (see Chapter 13).
5. Biological safety cabinets must be certified annually to ensure proper operation.
6. Physical containment devices, such as centrifuge safety cups and sealed centrifuge rotors must be used when procedures with a high potential for creating aerosols are being conducted with biohazardous materials.
7. HEPA filters are required on vacuum lines.
8. Autoclave must be available and used for disinfecting biohazardous waste before disposal.

Disposal of Biological Waste

Solid and liquid wastes from laboratory work with biological materials are considered biological wastes.

All biological wastes must be handled with the same procedures as biohazardous wastes:

- Liquid and semi-liquid biological wastes may be discharged to the sewer after disinfection. Chemicals, including preservative from biological specimens, may not be poured into the sewer. They must be handled as hazardous waste.
- Solid biological wastes must be autoclaved.
- Recognizable human anatomical remains must be cremated or interred.

- Research animals containing infectious agents must be incinerated.

Autoclaving Biological Wastes

Autoclaving is the primary method used at Whitworth to treat biological waste. To sterilize biological waste in a steam autoclave users must:

1. To ensure adequate steam penetration when treating biological waste, add 1 cup of water to dry loads and close the top of the bags, leaving a one-inch opening.
2. Consult written operating procedures for the steam autoclave, including time, temperature, pressure, type of waste, type of container(s), closure on container(s), pattern of loading, water content and maximum load quantity.
3. Check the recording and/or indicating thermometers during each complete cycle to ensure the attainment of a minimum temperature, pressure and time of: 121° C. (250° F.) at15 psi for 60 minutes to achieve sterilization of the entire load.
4. Thermometers shall be checked for calibration at least annually.
5. Maintain a logsheet for each decontamination load including: a) Date b) # Bags c) Name of operator d) Weight of bag e) Length of time at maximum temperature.

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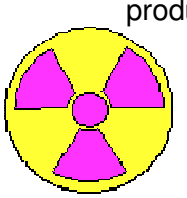
Chapter
26

Chapter 26 – Radiation Safety

The Radiation Safety program at Whitworth exists to protect faculty, staff and students when working with radiation and radiation producing machines.

Ionizing Radiation

The science departments own the following radioactive materials and radiation producing machines:



Radioactive Materials

Physics – One large chunk of autenite (uranium oxide ore)
One small jar of autenite chunks
One set of alpha and beta cloud chamber sources
One minigenerator
Assorted sealed check sources
Chemistry -- Several jars of radioactive reagents

The Physics department materials are stored in a locked wall vault in Room 137. The Chemistry department materials are stored in a locked wall cabinet in Room 202.

Radiation Producing Machines

Physics – One small cabinet-type tabletop X-ray machine, used for X-ray diffraction experiments. The use of this instrument is governed by State Regulations. It is stored in Room 137.

Rules

Ownership, storage, use, handling, and disposal of radioactive materials and radiation producing machines are subject to the Radiation Protection Rules, WAC 246-220 through 246-254, administered by the Washington State Department of Health. The Chemical Hygiene Officer has a copy of these rules, as well as copies of previous inspection reports for the X-ray machine. Please refer to the rules for detailed requirements regarding protection of employees and the public (e.g., students).

Waste Disposal

See the "Radioactive Waste" section of Chapter 14.

Non-Ionizing Radiation

WISHA regulations (WAC 296-62-09005) establish permissible exposure limits for non-ionizing radiation, and requirements for employee supervision, training, equipment labeling, and signage.

Lasers

Laser light, because it is focused and coherent, has the potential to cause damage to skin and particularly to eyes. All lasers and laser systems and/or devices in the U.S. are classified into one of several classes. Corresponding labels are affixed to the laser or laser system.

Understanding the laser classification is a fundamental prerequisite for any discussion of laser safety. Class 2 lasers have a low hazard potential, Class 3 lasers pose a moderate hazard, and Class 4 lasers pose a high hazard.

The science departments own the following functional lasers (not including laser pointers):

Chemistry

- Class 2 helium-neon laser, 633 nm wavelength, < 0-4 milliwatts (mW), inside the Perkin-Elmer infrared (IR) spectrometer in Room 209.
- Class 3b neodymium-YAG laser, 532-nm wavelength pulsed, 10-mW average, in the laser lab (inside Room 219).

Physics

- Five Class 2 helium-neon lasers, various wavelengths, < 2 mW max.
- Class 3b diode laser, variable wavelength, 40 mW, in Room 119.
- Class 4 carbon dioxide laser, 30 watts, student-built.
- Class 4 ArF argon-fluorine laser, 183nm.
- Class 4 Nd: YAG, A-switched, 2 watts, 10 ns pulses, 4,000 Hz, 532nm.

Protective Measures

Access to all Class 3b and Class 4 lasers is restricted by specifically locked doors. Only faculty and students under faculty supervision may use these types of lasers.

Both Chemistry and Physics own goggles designed to protect against the specific wavelengths of light generated by their Class 3b and Class 4 lasers. All persons using these lasers must wear the goggles at any time that there is a hazard of direct or reflected exposure to the beam.

Training

All employees who use lasers are required to receive laser safety training. This should be specific to the type(s) of laser they will be using, and documented. Copies of the documentation should be kept by the Chemical Hygiene Officer in a permanent training documentation file.

Information on laser safety is available in the “Laser Hazards” section of the OSHA Technical Manual, http://www.osha-slc.gov/dts/osta/otm/otm_iii/otm_iii_6.html.

Ultraviolet Light

Ultraviolet (UV) light can be a hazard to the eyes and skin, particularly in the near-UV-A spectral region (320 to 400 nm wavelength).

The permissible exposure limit for UV light is contained in WAC 296-62-09005(5).

Since Whitworth does not own a meter for measuring UV exposure, the best practice when using UV light sources is to avoid eye exposure to them as much as possible. While labs are occupied, it is the responsibility of the faculty or staff member to enforce this practice.

If equipment is set up to generate UV light while the lab will be unattended, it should be placed so that it cannot be seen from the hallway door if possible. Signs should also be posted warning of the eye hazard and instructing persons not to look at the UV light source.

Appendix A -- Laboratory Self-Inspection Form

All laboratory spaces will be inspected twice annually for compliance. This inspection will be done by the biology lab manager (for biology), the chemical hygiene officer (for chemistry), the chair of physics (for physics), and the chair of art (for art). The following Self-Inspection Form will serve as the template for laboratory self inspections.

Be sure to retain all documentation regarding inspections, including findings, and any actions taken.

Department: _____ Inspector: _____

Room(s): _____ Date: _____

For each item indicate **Y**es – **N**o or **N/A**

	1. Have all lab personnel reviewed and signed their own copy of the Lab Safety Plan?	Introduction
	2. Have copies of the training documentation been sent to the Chemical Hygiene Officer?	Introduction
	3. First aid kit available and contains all the specified items?	Chapter 1
	4. Lab personnel familiar with evacuation procedures, gathering point and preparations?	Chapter 2
	5. Lab personnel familiar with location and use of extinguishers in lab area? Extinguishers checked monthly?	Chapter 3
	6. Lab personnel know location of electrical panel and follow electrical safety precautions?	Chapter 4
	7. All hand tools in good condition?	Chapter 5
	8. All power tools properly guarded?	Chapter 5
	9. Lab personnel understand ergonomic risk factors in lab?	Chapter 6
	10. Relocation procedures followed when necessary?	Chapter 7
	11. Lab personnel know how to get chemical safety information, including MSDS?	Chapter 8
	12. Chemical safety information included in written lab procedures or safety SOPs?	Chapter 8
	13. Newly received chemicals all added to inventory, labeled and stored properly?	Chapter 9
	14. Chemical labeled and stored per Whitworth guidelines, including compatibility and labeling?	Chapter 10
	15. Hazardous materials storage locations identified?	Chapter 10
	16. Flammable materials in approved containers, no flammables in domestic refrigerators?	Chapter 10
	17. Fume hoods used properly, other engineering controls used when necessary?	Chapter 11
	18. Lab personnel understand PPE selection and include PPE requirements in written lab procedures or safety SOPs?	Chapter 12
	19. Lab personnel understand chemical spill response, including location of spill kit?	Chapter 13
	20. Chemical spill kit available and contains all the specified items?	Chapter 13
	21. Chemical wastes disposed per Whitworth guidelines and IMEX program used to decrease inventory if applicable?	Chapter 14
	22. Lab personnel understand carcinogens in use and precautions for handling them?	Chapter 15
	23. Controlled substances properly secured in storage?	Chapter 16
	24. Lab workers know highly toxic materials used and appropriate precautions?	Chapter 17
	25. Appropriate exposure monitoring has been done?	Chapter 18
	26. Peroxide-forming chemicals are tested quarterly for peroxide content?	Chapter 19

	27. Compressed gases used and stored per Whitworth requirements?	Chapter 20
	28. Manuals are present and referred to when operating centrifuges?	Chapter 21
	29. Traps are used consistently to keep liquids and vapors out of vacuum systems?	Chapter 21
	30. Lab personnel follow Whitworth procedures for safe autoclave use?	Chapter 21
	31. Ferromagnetic objects and susceptible persons are kept out of any 5-Gauss or higher magnetic fields?	Chapter 21
	32. Lab personnel follow Whitworth precautions when handling cryogenic liquids?	Chapter 22
	33. Workers follow Whitworth policies regarding human subjects?	Chapter 23
	34. Workers understand risks associated with animal handling?	Chapter 24
	35. Lab personnel know biosafety level of biologicals used and follow appropriate BSL practices?	Chapter 25
	36. Biological wastes handled according to Whitworth procedures, including autoclave procedures?	Chapter 25
	37. Ionizing radiation sources are stored and signed appropriately?	Chapter 26
	38. Appropriate protective goggles and signs are present for Class 3b and Class 4 lasers?	Chapter 26

Comments, questions and observations: _____

Appendix B – Relevant Rules, Standards and Guidelines

The Chemical Hygiene Officer has a copy of each of these, except the two local codes indicated by asterisks, for which he/she has only the tables pertaining to hazardous materials storage requirements.

Worker Safety and Health – WISHA

(Administered by the WA State Department of Labor & Industries.)

WAC Reference	Title
296-27	Recordkeeping and Reporting
296-260	Discrimination
296-24, Section A-1	General Educational. Medical and First-Aid Requirements
296-24, Section A-2	Personal Protective Equipment
296-24, Section B-1	Sanitation
296-24, Section B-2	Safety Color Code for Marking Hazards
296-24, Section C	Machinery and Machine Guarding
296-24, Section D	Materials Handling and Storage
296-24, Section E	Hazardous Materials, Flammable and Combustible Liquids
296-24, Section F-2	Storage and Handling of Anhydrous Ammonia
296-24, Section G-1	Means of Egress
296-24, Section G-2	Fire Protection
296-24, Section G-3	Fire Suppression Equipment
296-24, Section H-1	Hand and Portable Power Tools and Other Hand-Held Equipment
296-24, Section I	Welding, Cutting and Brazing
296-24, Section J-1	Working Surfaces, Guarding Floor and Wall Openings, Ladders
296-24, Section K	Compressed Gas and Compressed Gas Equipment
296-62, Section A	General
296-62, Section B	Access to Records
296-62, Section C	Hazard Communication
296-62, Section D	Controls and Definitions
296-62, Section E	Respiratory Protection
296-62, Section F	Carcinogens
296-62, Section G	Carcinogens (Specific)
296-62, Section H	Air Contaminants
296-62, Section I	Air Contaminants (Specific)
296-62, Section I-1	Asbestos, Tremolite, Anthophyllite and Actinolite
296-62, Section J	Biological Agents
296-62, Section J-1	Physical Agents

296-62, Section K	Hearing Conservation
296-62, Section L	Atmospheres, Ventilation, Emergency Washing
296-62, Section P	Hazardous Waste Operations and Emergency Response
296-62, Section Q	Hazardous Chemicals in Laboratories

Safety Equipment

ANSI Z358.1-1998 -- Emergency Eyewash and Shower Equipment (voluntary standard).

ANSI/AIHA Z9.5-1992 – Laboratory Ventilation (voluntary standard).

ANSI/ASHRAE 41.2-1987 – Standard Methods for Laboratory Airflow Measurements (voluntary standard).

ANSI/ASHRAE 110-1995 – Method of Testing Performance of Laboratory Fume Hoods (voluntary standard).

Fire Protection

Spokane County Fire Code.*****

Spokane County Building Code.*****

NFPA 30 – Flammable and Combustible Liquids Code (voluntary standard).

NFPA 45 – Standard on Fire Protection for Laboratories Using Chemicals (voluntary standard).

Hazardous Waste

Dangerous Waste Regulations, WAC 173-303 (administered by the WA State Department of Ecology).

Step-by-Step Guide to Better Laboratory Management Practices (guidance document from WA State Department of Ecology).

Hazardous Material Receiving, Shipping, and Transportation

49 CFR Subchapter C, Hazardous Materials Regulations (administered by the US Department of Transportation).

Radiation Protection

Radiation Protection Rules, WAC 246-220 through 246-254 (administered by the Washington State Department of Health).

Appendix C – Accident Report Forms

WHITWORTH UNIVERSITY
WORK RELATED ILLNESS/INJURY/ACCIDENT REPORT
(To be completed by injured party's supervisor)

Send copies within
24 hours of incident to: **Executive Secretary/Human Resources #0102**
Director of Safety/Physical Plant #3501

Name of Injured _____
(Last) (First) (MI)
Social Security Number _____-_____-_____

Home Phone # _____ Work Phone # _____

Home Address _____
(Street) (City) (State) (Zip)

Is Injured Party a Whitworth University: Regular Employee ___
Student Employee ___

PLEASE COMPLETE THE FOLLOWING:

Department in which employed _____

Job title _____

Salary _____

Was injured person acting in course of employment? _____

Will injury cause injured party to miss work? Yes ____ No _____
If Yes, when is employee expected to return to work?_____

Will the employee require light duty upon return to work? Yes ____ No ____
If yes, for how long? _____

Date of Accident _____ Time_____ a.m.____ p.m. _____
Location of Accident _____
_____

Describe the Accident _____
_____
_____
_____
_____
_____
_____
_____
_____

Were there any hazardous equipment or conditions which could have contributed to the accident? _____

If so, please describe_____
_____
_____
_____

Describe all bodily injuries:_____
_____
_____
_____

Identify any witnesses_____
(Name) (Phone number)

_____
(Name) (Phone number)

Signature of Supervisor _____

Date _____ Phone # _____

……

For HR use only: (Enter dates of action)

Report Received _____ Letter FMLA/SL/WC_____
W.C. Claim Received _____ Brochure to Employee _____
W.C. Filed _____
W.C. Acknowledged _____
W.C. Denied _____

……

For Safety Dept use only:

Whitworth University
Eric Johnston Science Center
Student Accident/Incident Report Form

Name of Injured _____
(Last) (First) (MI)

Student ID Number _____

Campus Phone #_____ Campus Address _____

Home Phone # _____

Home Address _____

_____

PLEASE COMPLETE THE FOLLOWING:

Department _____

Date of Accident _____ Time _____ a.m. ____ p.m. ____

Location of Accident _____

Describe the accident in your own words _____

_____

_____

Describe all bodily injuries _____

_____

_____

Were there any hazardous equipment or conditions which could have contributed to the accident? _____

If so, please describe: _____

_____

Describe preventive measures that could have avoided this accident _____

_____

Describe first aid measures taken (To be filled out by First Responder) _____

_____

_____

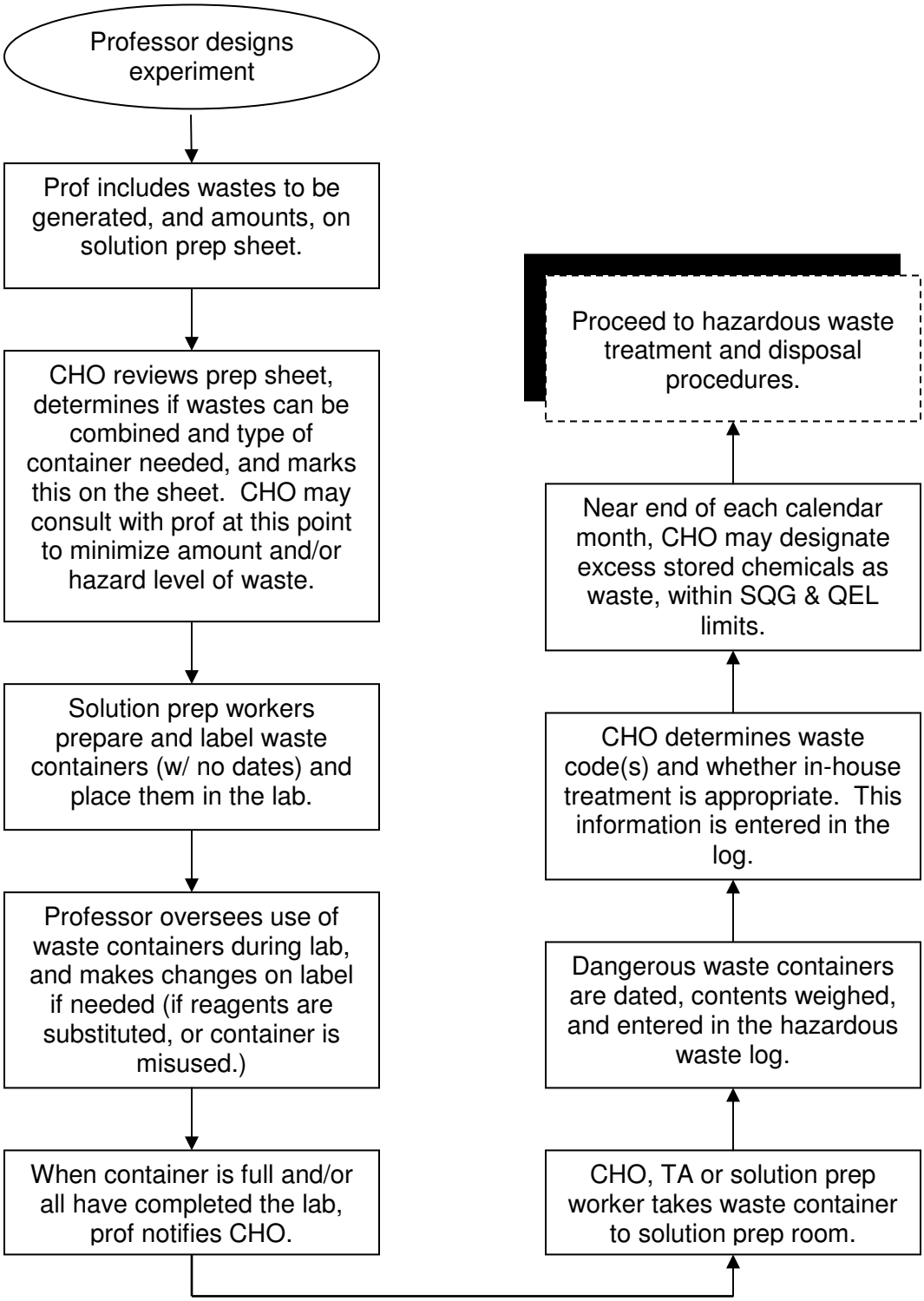
Identify any witnesses_____
(Name) (Phone Number)

_____
(Name) (Phone Number)

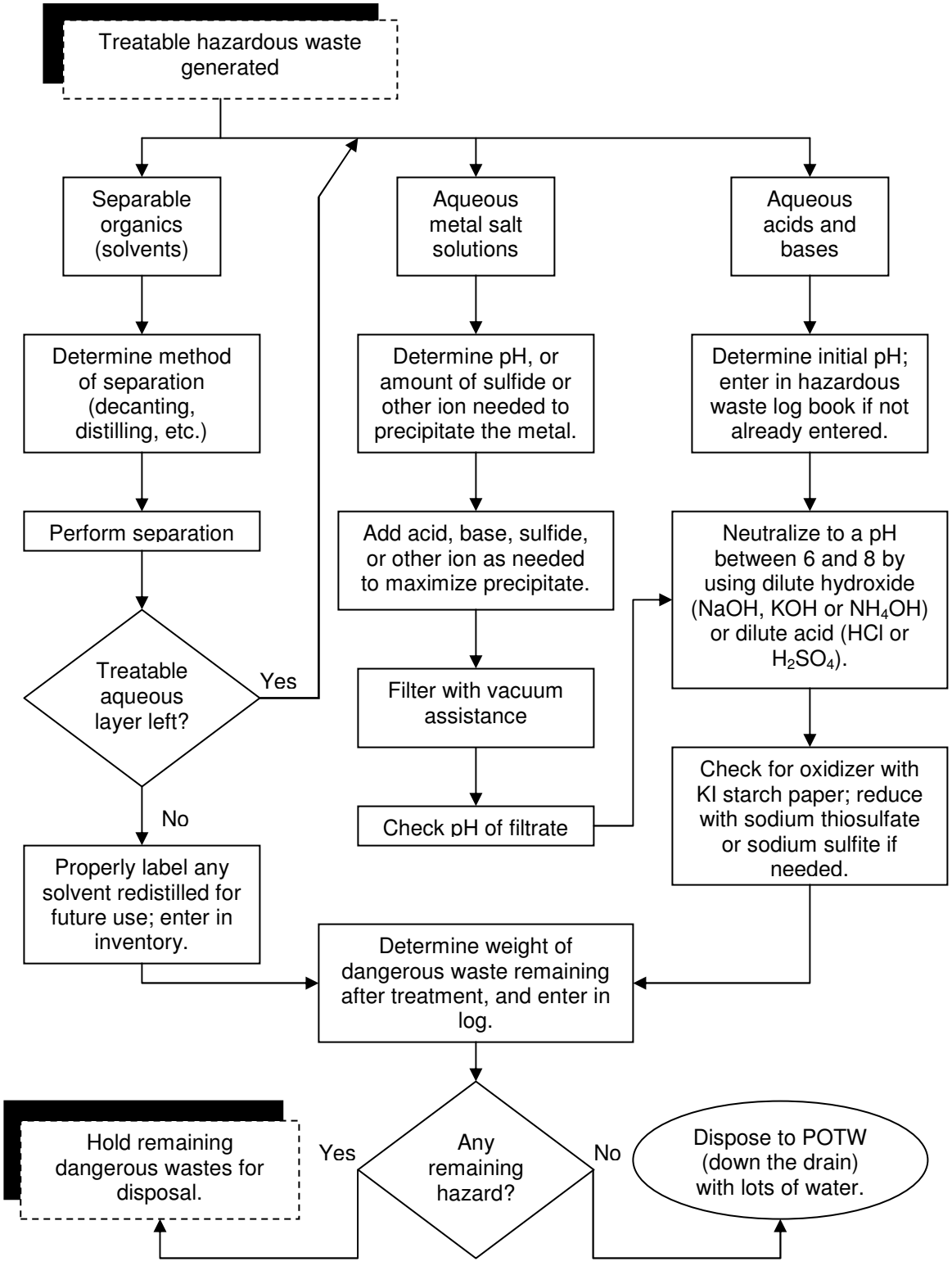
Signature of Injured Party _____ Date_____

Signature of Person Taking Report_____

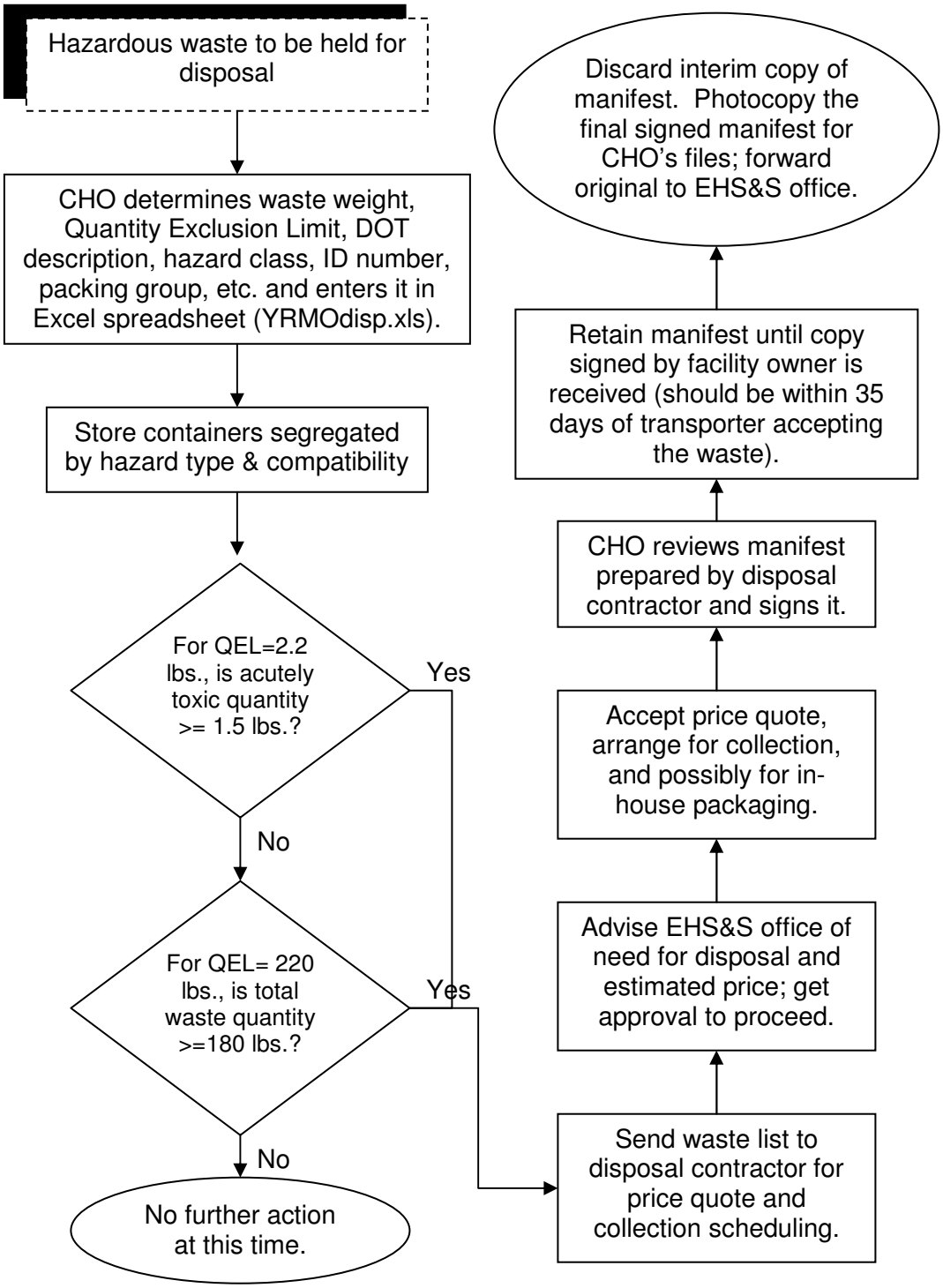
Appendix D – Hazardous Waste Generation Flowchart



Appendix E – Hazardous Waste Treatment Flowchart



Appendix F – Hazardous Waste Disposal Flowchart



Appendix G – Carcinogen Listing

The following chemicals are:

- regulated as carcinogens by WISHA; or
- listed in the category "known to be carcinogens" in the latest National Toxicity Program (NTP) Report on Carcinogens (http://ntp-server.niehs.nih.gov/Main_pages/NTP_8RoC_pg.html); or
- listed in Group I, "carcinogenic to humans," in the latest edition of the International Agency for Registration of Carcinogens (IARC) monographs (http://193.51.164.11/).

NOTE: In addition to this list, "carcinogens" also includes chemicals listed in Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogenic" by NTP which cause statistically significant tumor incidence in experimental animals as described in WAC 296-62-40003(25)(d). They are not listed here; see the criteria in the WAC, research reported in the RTECS and the latest lists at the IARC and NTP websites to determine additional carcinogens.

Chemical	CAS Number	WISHA Reg.	NTP	IARC
2-Acetylaminofluorene	53-96-3	WAC 296-62-073		
Acrylonitrile	107-13-1	WAC 296-62-07336		
Aflatoxins	1402-68-2		Known	Group 1
4-Aminodiphenyl	92-67-1	WAC 296-62-073	Known	Group 1
Arsenic: copper acetoarsenite and all inorganic compounds except arsine	7440-38-2	WAC 296-62-07347	Known	Group 1
Asbestos	1332-21-4		Known	Group 1
Azathioprine	446-86-6		Known	Group 1
Benzene	71-43-2		Known	Group 1
Benzidine	92-87-5	WAC 296-62-073	Known	Group 1
Beryllium & beryllium compounds	7440-41-7			Group 1
N,N-Bis(2-chloroethyl)-2-naphthylamine (Chlornaphazine)	494-03-1			Group 1
Bis-chloromethyl ether	542-88-1	WAC 296-62-073	Known	Group 1
1,4-Butanediol Dimethylsulfonate (Myleran®; Busulfan)	55-98-1		Known	Group 1
Cadmium and all cadmium compounds	7440-43-9	WAC 296-62-074		Group 1
Chlorambucil	305-03-3		Known	Group 1
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (MeCCNU)	13909-09-6		Known	Group 1
Chromium Hexavalent (under Chromium and Certain Chromium Compounds)			Known	Group 1
Coal Tar (under Soots, Tars, and Mineral Oils)	8007-45-2		Known	Group 1
Coke Oven Emissions			Known	

Creosote (Coal) (under Soots, Tars, and Mineral Oils)	8001-58-9		Known	
Creosote (Wood) (under Soots, Tars, and Mineral Oils)	8021-39-4		Known	
Cyclophosphamide	50-18-0		Known	Group 1
Cyclosporin A (Cyclosporine A; Ciclosporin)	59865-13-3		Known	Group 1
1,2-Dibromo-3-chloropropane	96-12-8	WAC 296-62-07342		
3,3'-Dichlorobenzidine and its salts	91-94-1	WAC 296-62-073		
Diethylstilbestrol	56-53-1		Known	Group 1
4-Dimethylaminoazobenzene	60-11-7	WAC 296-62-073		
Epstein-Barr virus				Group 1
Erionite	66733-21-9		Known	Group 1
Ethyleneimine	151-56-4	WAC 296-62-073		
Ethylene oxide	75-21-8	WAC 296-62-07355		Group 1
Human papillomavirus types 16 & 18				Group 1
Human T-cell lymphotropic virus type I				Group 1
Lead Chromate (under Chromium and Certain Chromium Compounds)	7758-97-6		Known	
Melphalan	148-82-3		Known	Group 1
Methyl chloromethyl ether	107-30-2	WAC 296-62-073	Known	Group 1
4,4'-Methylene bis(2-chloroaniline)	101-14-4	WAC 296-62-073		
Methylene chloride	75-09-2	WAC 296-62-07470		
Mineral Oils			Known	Group 1
Mustard Gas	505-60-2		Known	Group 1
Alpha-Naphthylamine	134-32-7	WAC 296-62-073		
Beta-Naphthylamine	91-59-8	WAC 296-62-073	Known	Group 1
Nickel compounds				Group 1
4-Nitrobiphenyl	92-93-3	WAC 296-62-073		
N-Nitrosodimethylamine	62-75-9	WAC 296-62-073		
Phenacetin, Analgesic Mixtures Containing			Known	Group 1
Piperazine Estrone Sulfate (under Conjugated Estrogens)	7280-37-7		Known	
Beta-Propiolactone	57-57-8	WAC 296-62-073		
Radon	10043-92-2		Known	Group 1
Silica, crystalline (inhaled in the form of quartz or cristobalite from occupational sources)	14808-60-7			Group 1
Sodium Equilin Sulfate (under Conjugated Estrogens)	16680-47-0		Known	
Sodium Estrone Sulfate (under Conjugated Estrogens)	438-67-5		Known	
Soots			Known	Group 1
Strontium Chromate (under Chromium and Certain Chromium Compounds)	7789-06-2		Known	
Talc containing asbestiform fibers				Group 1
Tars			Known	

2,3,7,8-Tetrachlorodibenzo-para-dioxin				Group 1
Thorium Dioxide	1314-20-1		Known	
Tris(1-aziridinyl)phosphine Sulfide (Thiotepa)	52-24-4		Known	Group 1
Treosulfan				Group 1
Vinyl chloride	75-01-4	WAC 296-62-07329	Known	Group 1
Wood dust				Group 1
Zinc Chromate (under Chromium and Certain Chromium Compounds)	13530-65-9		Known	