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Occupational Exposure to Hazardous Chemicals in Laboratories and the United Nations Globally Harmonized System (GHS)

1910.1450 - Occupational Exposure to Hazardous Chemicals in Laboratories.

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I. Introduction:

The University of Wyoming (UW) continually strives to provide a learning, teaching, and research environment free from recognized hazards. Academic and Research laboratories in a higher education environment that utilize chemicals present potential hazards that require support and involvement form upper administration, throughout the organization to the individual laboratory worker or student.

Pursuant to the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.1450- Occupational exposure to hazardous chemicals in laboratories. and the changes due to the United Nations Globally Harmonized System (GHS) the University establishes this Chemical Hygiene Program (CHP) to protect employees and students from potential health hazards associated with the handling, use, and storage of hazardous chemicals in laboratories.

II. Purpose:

A. The purpose of the “umbrella” Chemical Hygiene Program at the UW is to ensure that laboratory workers are effectively informed about Safety and health hazards associated with the chemicals in their workplace, and are provided with working conditions that will prevent harmful exposure to chemicals. Deans, Directors, Department Heads / Chairman, and the Principal Investigators must accept and implement the University Chemical Hygiene Program. Additionally, the purpose of this program is to meet the requirements of a written Chemical Hygiene Plan as required by 29 CFR 1910.1450, occupational exposure to hazardous chemicals in laboratories. This regulation is commonly referred to as the OSHA Laboratory Standard.

B. This program provides for:

1. Minimization of employee exposure to regulated chemicals at or below the OSHA permissible exposure limits
2. Determination of employee exposure to regulated chemicals
3. Proper training in recognition of hazards, safe handling and use of chemicals for laboratory employees (workers)
4. Medical consultation and/or medical examinations
5. Hazard identification
6. Record keeping

III. Scope:

All laboratory “Employees (workers)”: faculty, staff, post-docs, graduate students, undergraduate students and non-employees are expected to work in a safe manner, implementing the information in this program.

A. "Employee (worker)" is any person receiving a UW paycheck, independent of the source of funds. This program covers all university employees working in or out of a laboratory setting who might be exposed to hazardous chemicals in the course of their assignments.

B. The general concepts of the Chemical Hygiene Program should be extended to students not employed by the UW in teaching laboratories and other structured teaching situations. However, the specific requirements as addressed to employees may not be applicable or

practical in some cases. In particular, the requirements called for in Section V. Medical Consultation and Exams; Section VII. Training: and Section IX. Air Monitoring; will be addressed for these students in detail in the Student Safety Program and department policies.

C. Non-employees of outside agencies using UW laboratory facilities who might be exposed to hazardous chemicals in a laboratory are covered by the requirements of this standard. Outside agencies utilizing UW laboratory facilities may develop their own chemical hygiene program and it must cover the areas described by 29 CFR 1910.1450.

D. **Laboratory** means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis. Laboratories may include:

1. Research laboratories
2. Teaching laboratories
3. University research stations
4. University agricultural and livestock farms

IV. Responsibilities:

A. **The University of Wyoming** is responsible for ensuring the Safety of its employees and for complying with all applicable requirements of state and federal regulations. The UW administration considers Safety an important priority. All UW employees at all levels are encouraged to promote a positive Safety culture in their tasks, assignments, work practices and while interacting with others. The trustees and the president of the University of Wyoming have acknowledged the need for a safe working environment.

B. **UW Safety** in order to assist University departments. The UW Safety provides oversight and technical consultation on environmental, health, and safety issues at UW. To that end UW Safety has been charged "with the planning and implementation of action to meet the requirement of all applicable health and safety legislation and associated rules and regulations."

C. **The Director of UW Safety** and his/her designee have the authority "necessary to ensure the safety of the University community, including the authority to vacate and close down University facilities, projects or activities. For chemical Safety issues, the Chemical Safety Specialist is the primary designee.

D. **The Chemical Safety Specialist** will serve as the Chemical Hygiene Officer and will coordinate and oversee the implementation of the “OSHA Laboratory Standard, 29 CFR 1910.1450. The major responsibilities of the Chemical Safety Specialist include:

1. Annually review and update as needed this Chemical Hygiene Program
2. Implement the Chemical Hygiene Program in coordination with Laboratory Safety Coordinators from affected departments
3. Coordinate and implement responsibilities assigned to UW Safety from this program
4. Act as an advisor to the Laboratory Safety Coordinators and laboratory workers

5. Inspections of all laboratories at least annually

F. **Deans, Directors, Department Heads / Chairman** are responsible for the overseeing and supporting the implementation of this Chemical Hygiene Plan in his/her department. In addition, this individual will assign a departmental laboratory Safety coordinator.

G. **Departmental Laboratory Safety Coordinator** is required for each department and outside agency that occupies UW laboratory facilities. The director or department head/chairman will appoint a Department Laboratory Safety Coordinator. With help and direction from the University Chemical Safety Specialist, the responsibilities of the Departmental Safety Coordinator include:

1. Assist in the implementation of the Chemical Hygiene Program at the departmental level
2. Act as an advisor to laboratory workers in the respective department
3. Act as an advisor to PI's, faculty, staff and students in the respective department
4. Assist in sharing of Safety related information provided by UW Safety Department
5. Respond to safety questions or concerns about potential safety and health situations for both non-laboratory and laboratory areas

H. **Principal Investigators (PI)** are assigned specific duties in the Chemical Hygiene Program and associated policies. In general, PI's are responsible for the safe use of hazardous chemicals in their laboratories. Other responsibilities include:

1. Developing and implementing written standard operating practices (SOP's), as needed for situations and processes that may result in personal injury or illness (including exposure to carcinogenic chemicals)
2. Notifying UW Safety (766-3277) immediately: of any accident or incident, which may result in the personnel being exposed to chemicals or released to the environment.

In addition, the **Principal Investigator** has the overall responsibility for compliance with the CHP in his/ her laboratory. This responsibility may not be shifted to inexperienced or untrained personnel. The investigator must assure that:

1. Laboratory workers and others entering laboratory know and follow chemical hygiene rules
2. Required appropriate laboratory attire is worn: no shorts, skirts or sandals
3. Appropriate protective equipment is provided, is in working order
4. Appropriate training has been provided to all occupants of the laboratory
   a. This includes laboratory safety training provided by UW Safety and laboratory specific training
5. Unsafe acts, conditions or inadequate facilities are reported to their Dean, Director, Department Head / Chairman, Laboratory Safety Coordinator and to UW Safety
6. Conducts (or ensures) weekly / monthly inspections to see if life safety equipment has been checked by the PI or his/her designee:
   a. Availability of Personal Protective Equipment (PPE)
   b. Availability and location of Safety Data Sheets (SDSs)

c. Emergency eyewash stations (weekly)

I. **Laboratory employee (worker)** is responsible for complying with this program for their own protection, as well as that of fellow workers and the public. In addition, each employee or student is responsible for reporting to their PI, all facts related to any accident resulting in personal injury or exposure to hazardous chemicals.

V. Medical Consultations / Examinations:

A. The university will provide to all employees who work with hazardous chemicals in a laboratory a program of medical monitoring, offered under conditions outlined in the following Section B. Agencies other than the UW operating in UW laboratory facilities are responsible for maintaining a similar program and shall assume costs associated with the program.

B. For any worker who works with hazardous chemicals, a medical consultation and/or examination will be offered under the following circumstances:

1. Employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory
2. Exposure monitoring reveals an exposure level routinely above the action level (Permissible Exposure Limit (PEL) in the absence of an action level)
3. Event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure. In such a case, a medical consultation shall be offered for the purpose of determining the need for a medical examination

C. Medical consultations and/or examinations will be performed by or under the direct supervision of a licensed physician.

D. The medical consultation and/or examination will be provided without cost to the employee, without loss of pay and at a reasonable time and place. A Workers' Compensation Report of an injury or exposure should be filed with the Human Resources Office.

E. The employee, with help from the department and PI will provide the physician with the following information:

1. A Safety Data Sheet (SDS) of the chemical to which he/she may have been exposed
2. A description of the conditions under which the exposure occurred
3. Description: of the signs and symptoms of exposure that he/she is experiencing, if any

F. The employee must ensure that a written opinion from the physician is sent to the University Chemical Safety Specialist, UW Safety, with the following information:

1. Recommendation for further medical follow-up
2. Results of the medical examination and any associated tests
3. Any medical condition, which may be revealed in the course of the examination, which may place the employee at increased risk as a result of exposure to a hazardous chemical found in the workplace
4. Statement that the employee: has been informed by the physician of the results of the

consultation or examination and any medical condition that may require further examination or treatment

5. Written opinion shall not reveal specific findings of diagnoses unrelated to the occupational chemical exposure
6. The written records of physicians will be maintained securely by UW Safety for at least 30 years after the employee leaves the university

VI. Hazard Identification:

A. Labels

1. All chemical containers are required to bear a label marked with the **Full** Chemical Name of the contents, that identity it and the appropriate hazard warning(s). Manufacturer labels are sufficient
2. Labels on containers shall not be removed or defaced until the container is emptied
3. If a label is unintentionally removed or defaced, a new label shall be applied marking the contents and hazards
4. When a chemical is transferred to a secondary container, the new container shall be labeled with the **Full** Chemical Name of the contents and hazard(s)
5. Labels may **NOT** bear acronyms or abbreviations, unless a list of the Full Chemical Name with the acronyms or abbreviations is posted near the door inside the laboratory
6. If a rack of vials or tests tubes or similar containers: all contain the same hazard class of chemicals, the rack may be labeled in lieu of labeling each individual small container
7. If an empty container is being disposed, the label shall be defaced, removed, or marked "empty"

B. Safety Data Sheets, SDSs

1. Suppliers and/or manufacturers are required, by state and federal law, to supply a Safety Data Sheet (SDS) to the user on all "first time" orders or when a revision in a given SDS is made
2. The PI is responsible for maintaining a workplace SDS file. This file must take the form of paper files, and may be shared by multiple laboratories of a PI
   a. This file shall be available to employees or students during hours that they will be working with hazardous chemicals, 24/7
   b. The PI shall notify any personnel of the location of the SDS files with a sign on the outside of the laboratory door
3. UW Safety will maintain a master SDS file, this file is a primary online system provider as designated by UW Safety and a paper copy located in the Regulated Materials Management Center (RMMC)
   a. Copies of SDS's are available for the workplace online by UWs primary online system provider or by calling 766-3696 for hard copies
   b. Every SDS received from a source other than UW Safety primary online source will be copied and sent to the UW Safety/RMMC master file
   c. University personnel have access to SDSs from the primary online source, which is

a web-based online site with over 7+ million SDSs, see the UW Safety website for access

4. Chemical substances developed in the laboratory for which the University does not have an SDS, the following shall be implemented:
   a. If the chemical's composition is known and it is to be used exclusively in the lab, the PI shall determine whether the chemical is hazardous. If it is hazardous, the PI shall provide training to all employees as specified in Section VII (Training)
   b. If the chemical produced is a byproduct whose composition is not known, the laboratory employees shall assume that the substance is hazardous and appropriate Sections of this program shall be followed
   d. If the chemical is produced for another user outside the university or another department on campus, an SDS must be prepared and provided to the other user; and the container must be labeled

VII. Training:

All laboratory employees: faculty, adjuncts, staff, post-docs, graduate students, undergraduate students and any outside scientists in the laboratory workplace will be trained concerning harmful exposure to chemicals by taking the Occupational Exposure to Chemicals in the Laboratory Training. All non-laboratory worker's will be required to take Workplace Chemical Safety (Hazardous Communication Training) for custodians, office help, security personnel and any others who might be exposed to harmful level of chemicals from laboratories in the performance of their duties.

A. Employee associated with laboratories will attend this training at least once at the first available class after employment

B. Training will be documented; hard copy of the records will be maintained in UW Safety for 3 years and electronically by HR system

C. UW Safety provides online Laboratory Safety training. This training will include:

   1. The components; of the university's written Chemical Hygiene Program responsibilities
   2. Air monitoring requirements
   3. Rights to medical consultations and/or examinations
   4. Hazard identification including methods and observations that may be used to detect the presence or release of a hazardous chemical
   5. The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used
   6. An overview of the various safety policies relating to chemicals

D. Laboratory Safety Refresher will be required every 3 years and documented by hard copy and the HR system. Laboratory employees may attend the laboratory Safety training for UW Safety new employees or laboratory refresher training and online training. These classes are provided by UW Safety online

E. Deans, Department Heads, Directors and PI's are responsible for training employees and volunteers in **research laboratories** under their supervision in the following areas, with hard copy documentation of the training:

1. Methods and observations: that may be used to detect the presence or release of a hazardous chemical (for example, continuous monitoring devices, visual appearance or odor of hazardous chemicals)
2. Physical and health hazards: of the chemicals in the work area
3. Measures employees can take to protect themselves from these hazards
4. Standard operating procedures of the research laboratory
5. Location of designated areas for particularly hazardous substances, including "select carcinogens," as specified in the Chemical Safety Guidelines

E. Deans, Department Heads, Directors, PI's and graduate teaching assistants are responsible for training students in **teaching laboratories** in the following areas, with hard copy documentation of the training:

1. Methods and observations: that may be used to detect the presence or release of a hazardous chemical (for example, continuous monitoring devices, visual appearance or odor of hazardous chemicals).
2. Physical and health hazards: of the chemicals used in that particular class.
3. Measures students must take to protect themselves from these hazards.
4. Departmental laboratory standard operating policies.
5. The location of designated areas for particularly hazardous substances, including "select carcinogens," as specified in the Chemical Safety Guidelines.

F. Records for the training of employees and volunteers by departments will be documented with employee signature or initials, date, instructor's name, location of training and an outline of the class.

G. Records for the training of students will be documented by class outlines, which are to be maintained by the department. The original or legible copy of training documentation for employees or volunteers shall be forwarded to UW Safety.

VIII. Departmental Standard Operating Procedures, SOPs:

A. Departments and PI's are responsible for developing standard operating procedures, SOP, that will address how provisions of this Chemical Hygiene Program and associated policies will be implemented specifically in their department.

B. Copies of these policies, referred to as the Departmental Chemical Hygiene Program, will be forwarded to University Chemical Safety Specialist.

IX. Air Monitoring:

It is the university's policy to minimize employee exposure to harmful concentrations of hazardous chemicals.

A. If there is reason to believe that employee's exposure may exceed regulated acceptable

levels (Refer to the UW Air Monitoring Policy), workplace monitoring shall be performed.

B. UW Safety will be responsible for air monitoring for chemicals listed in Wyoming Occupational Health and Safety substance-specific standards. A list of those substances may be found at the following website link.

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C. Deans, Department Heads, Directors and PI's maybe responsible for the associated costs of air monitoring, as well as the analysis.

D. Copies of all results of air monitoring will be sent to the University Chemical Safety Specialist.

X. Laboratory Safety Guidelines

I. Purpose, Scope, and Responsibilities:

A. The following guidelines include a list of behaviors designed to promote human health and safe work practices associated with experimental laboratory work.

B. Some topics may have been addressed in separate policies or programs and are not included in these guidelines.

C. Each employee or student should be aware of their own activities, as well as others in the same work area, and ultimately are responsible to ensure their own safety.

II. General Guidelines:

A. Wear eye protection at **All** times in the laboratory, when any chemical work is taking place. Refer to the Eye Protection Policy. The only exception to this rule occurs when employees or students are looking through microscopes.

B. Each employee or student must become familiar with the chemical's hazards prior to use.

1. Use appropriate safeguards for that chemical.
2. Know the location and proper use of emergency equipment.
3. Know where and how to store the chemical.

C. Become familiar with the chemical operation and hazards involved before beginning.

D. When transporting chemicals between floors of a building, avoid riding with the chemicals in an elevator whenever possible. Transport the chemicals using a freight elevator if one is available.

III. Housekeeping and Chemical Storage:

A. Access to emergency equipment, showers, eyewashes and exits should never be blocked or obstructed.

B. Keep all aisles, hallways, and stairs clear of chemicals and clutter. Counter tops should be kept clear of clutter.

C. Promptly clean up small/low hazard spills and dispose of the spilled chemical and cleanup materials properly. Contact UW Safety 766-3696 for spill response assistance. Refer to the Spill Control Policy.

D. All chemicals should be placed in their assigned storage areas at the end of each day.

1. Fire-hazard chemicals must be stored in a flammable-solvent storage area or in storage cabinets designed for flammable materials.
2. Assure chemical compatibility, proper ventilation and spill containment in storage areas.
3. Date chemicals: on the label when the container is first opened.
4. Store waste chemicals separately and label according to "Waste Disposal Guidelines".

IV. Personal Hygiene:

A. Wash promptly whenever a chemical has contacted skin.

1. Use soap and water; do not wash with solvents
2. Wash thoroughly before leaving the laboratory
3 Wash for a minimum of 20 seconds

B. Remove lab coat and gloves on exiting the laboratory.

C. Do not eat, drink, chew gum, smoke or apply cosmetics in the laboratory. Food shall not be stored in laboratory refrigerators.

D. Use suction bulbs for pipetting; do not use mouth suction.

E. Do not "sniff" chemicals. Avoid inhaling toxic vapor and gases; use fume hoods when indicated by the SDS, or if the chemical must be used in designated areas.

V. Safety Equipment:

A. Fire extinguishers shall be readily available in all laboratories.

1. Units shall meet requirements of International National Fire Code, IFC
2. Laboratory workers should be familiar with the location and use of extinguishers.
3. Physical Plant is responsible for the inspection and replacement of fire extinguishers. If one is discharged, the Physical Plant Service Desk (766-6225) should be notified.

B. Eyewashes and Safety showers should be accessible from every laboratory.

1. Keep access: to eyewash fountains and Safety showers unrestricted
2. UW Safety will conduct a quarterly inspection of all eyewashes and safety showers. UW Safety will retain documentation of the inspections electronically.
3. Eyewashes: shall be tested **weekly** by the laboratory PI/supervisor to ensure that they are operational. Tags will be placed on all eyewashes; the weekly inspections will be documented with initials and the date. During the inspection, the following items should be checked:

   a. Is there sufficient water flow?

   b. Are particulates present which could be forced into an eye if used; e.g. corrosion products?

   c. If bottle eyewashes are used, solutions must be changed monthly and bottles washed.

C. If a fire alarm sounds, the building shall be evacuated according to procedures described in the Emergency Response Plan, ERP. Fire alarms are connected to the UW Police Department (UWPD) and **NOT** the Laramie Fire Department. The individual sounding the alarm should also call the UWPD, 307-766-5179.

D. Each department shall maintain spill control kits appropriate to the hazards of the chemicals used in their laboratories.

1. Kits should be easily accessible to employees in all labs at any time the lab workers are using hazardous chemicals.
2. Signs must be posted on the exterior of the lab doors stated where spill kits are located.
3. Refer to the Spill Control Policy: for information on training in the use of spill kits and disposal of materials after the spill is cleaned.

E. Personal protective equipment shall be worn when recommended by the SDS or literature.

1. Safety glasses shall be worn at **All** times in the laboratory. Refer to the Eye Protection Policy.
2. Respirators should be worn only if other means of control such as fume hoods or glove boxes are not feasible. Their use is covered in the Respiratory Protection Program.
3. Departments will be responsible for purchasing gloves, lab coats, face shields or other personal protective equipment for employees.

VI. Inspections:

A. UW Safety will conduct laboratory inspections annually. The inspections will be either announced or unannounced. Reports will be sent electronically to the responsible person for the lab and a written or electronic reply expected. Items that will be inspected include but not limited to:

1. Housekeeping
2. Maintenance requirements
3. Personal protective equipment
4. Labeling
5. Safety Data Sheets
6. Storage
7. Ventilation system operation
8. Signage
9. Fire Safety
10. Chemical Inventory of ALL Chemical Materials in a barcoding system

B. **Laboratory Self-surveys**

a. Since the UW Safety lab inspections only occur at least annually, laboratory personnel are encouraged to utilize the laboratory self-survey form included in this document. The PI will complete the laboratory self-survey form and return a copy to UW Safety. Chemical Safety Specialist will follow-up appropriately with the PI to address any Safety issues identified.

VII. Handling and Use of Flammable Chemicals:

A. Chemicals with flash points below 200°F will be considered "fire hazard chemicals."

B. These chemicals must be stored in a flammable-solvent storage area: storage cabinets

designed for flammable materials or approved Safety cans with spring loaded cap and flame arrestor.

C. Use only in vented hoods and away from sources of ignition.

D. When transferring flammable liquids between conductive containers, provide bonding (through metal to metal or bonding wire) to prevent sparks from static electricity.

E. Do not use or store near oxidizers or ignition sources.

F. A partial list of Pyrophoric Chemicals.

VIII. Handling and Use of Corrosive and Contact-Hazard Chemicals:

A. Chemicals: that cause visible destruction of or irreversible alterations in living tissue by chemical action at the site of contact or has a pH greater than 12 or less than 2.5 (40 CFR 261.22) will be considered corrosive chemicals.

B. Chemicals that are identified or described in SDSs, labels, or medical or industrial literature as allergies or sensitizers will be considered contact hazard chemicals.

C. Handle these chemicals with proper safety equipment, including safety goggles or shields, gloves resistant to permeation, and a lab coat or apron.

D. Do not store or use corrosives near toxicants, flammable, or substances that release corrosive, toxic or flammable vapors upon reaction. Store acids separate from bases.

IX. Handling and Use of Reactive Chemicals:

A. Chemicals that are capable of detonation, explosive reaction, explosive chemical change, or are either oxidizers or organic peroxides will be considered reactive chemicals (Shock Sensitive Chemicals). Further definitions can be found in the National Fire Protection Agency's (NFPA) Manual 325M, Manual 49, and Manual 491M; Department of Transportation 49CFR; the Environmental Protection Agency 40CFR 261.23; and the Occupational Health and Safety Act 29CFR 1910.1450.

B. Segregate reactive chemicals in storage areas.

C. Design reaction experiments with safety or barrier shields, with controls for heating and stirring outside the shielded area.

D. Perform experiments involving the heating of Perchloric acid in Perchloric acid hoods. If one is not readily available, call UW Safety for help in arranging for the use of one. See Safe Use of Perchloric acid.

E. Use and store the minimum amounts required by the experiment.

F. Follow all Safety precautions listed on the SDS or in the literature.

G. Peroxidizable compounds are insidious. Date the container when received and check for peroxides biannually, documenting the findings on the label. A discussion and list of Peroxidizable Compounds.

H. Water Reactive Chemicals reactivity may manifest as explosivity, generation of toxic or explosive gases or exothermicity. Consult the available literature regarding these chemicals.

X. Handling and Use of Toxic Chemicals:

A. Chemicals that cause adverse health effects, by attacking body tissues, organs or organ systems, causing cancer (carcinogens), affecting fetuses (teratogen), or by interfering with normal reproduction through chromosomal damage (mutagens) will be considered toxic chemicals.

B. To control exposure (whether be by inhalation, absorption or ingestion) implement the following controls in this order:

   1. Substitute a less hazardous chemical.
   2. Use engineering controls, such as fume hoods or glove boxes.
   3. Use administrative controls, such as standard operating procedures, restriction of access or establishment of designated areas.
   4. Use personal protective equipment, such as respirators, gloves, goggles, etc. consistent with recommendations found in the Safety Data Sheet (SDS).

C. Supervisors will determine which level of control will be used for all toxic chemicals, and whether air monitoring will be performed (Refer to the Air Monitoring Policy).

D. If a chemical adheres to one of the following criteria, it will be considered a carcinogen (current list are included as Select Carcinogens):

   1. Regulated by OSHA as a carcinogen.
   2. Listed under the category, "Known to be Carcinogens" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition).
   3. Listed under Group 1 ("Carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions).
   4. It is listed in either Group 2A or 2B by IARC or under the category, "Reasonably Anticipated to be Carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
      a. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3.
      b. After repeated skin application: of less than 300 (mg/kg of body weight) per week.
      c. After oral dosages: of less than 50 mg/kg of body weight per day.

E. If a chemical is listed as having a high degree of acute toxicity or is a reproductive toxin in the SDS, the same procedures will be followed as if it were a carcinogen. a list of Acutely Toxic Chemicals, a list of Acutely Toxic Gases and a discussion of the Hazards of Mercury.

F. For those chemicals considered being carcinogens (including reproductive toxins and chemicals with a high degree of acute toxicity) the following controls will be required when dealing with toxicologically significant quantities:

   1. All work with those chemicals shall be done within a laboratory fume hood, glove box or other containment device, which can be easily decontaminated.
   2. Containment devices shall be called a designated area and will be so marked with appropriate signage.

3. All employees shall wear, at a minimum, a lab coat, eye protection and appropriate gloves.
4. Equipment contaminated with the carcinogen shall be decontaminated at the end of the procedure. All wastes will be disposed of through UW Safety Hazardous Waste Program.

G. Know the health hazards of the chemicals involved ahead of time, including means of detecting their release, signs and symptoms of exposure, and personal protection required and emergency procedures in case of a spill or other release. Follow all safety precautions listed on the SDS or in the literature.

1. If using fume hoods, assure that the hood is working properly.
2. If using personal protective equipment, inspect it prior to use to identify defects, which may compromise its effectiveness (such as pinholes, tears, discoloration, stiffness). If it is visibly damaged or contaminated, it may not be used.

XI. Handling and Use of Compressed Gases:

A. Hazards from compressed gases are due to pressure and the chemical nature of the gas. The following rules are derived from the Handbook of the Compressed Gas Association, The Guide for Safety in the Chemical Laboratory, and OSHA Standards.

B. Label all cylinders with the contents.

C. Keep the valve protection cap on securely unless the pressure regulator is attached.

D. Storage

1. Store: empty and full cylinders separately.
2. Group cylinders: by chemical hazard type.
3. Store away from sources of heat, ignition, oil, grease or where they might become part of an electrical circuit and out of the way of traffic.
4. Limit storage: of corrosive gases to about three months. Work the valve frequently to prevent freezing. Close the valve when not in use.
5. Cylinders may be stored in the open, out of the way of traffic and protect the bottom from the ground to prevent rusting.
6. Do not store at low temperatures without the approval of the manufacturer because the steel may undergo decreased ductility and crack.

E. Secure the cylinder with straps, chains, ropes, clamps or floor stands to prevent it from falling.

F. Use only a regulator designed for the gas being used. Never use an adaptor fitting.

G. Before connecting the regulator, open the valve slightly and close immediately unless the gas is toxic. Point the opening away from the body and not toward anyone else.

H. Do not touch or wipe the valve outlet on an oxygen cylinder in such a way that organic residues are deposited.

I. Attach the regulator with the valve closed. Open the cylinder valve slowly and then set the

regulator to the correct pressure.

J. Check for gas leaks with soapy water or a commercial leak detector.

K. Do not use copper tubing with acetylene.

L. Bond and ground all cylinders, lines and equipment used with flammable compressed gases.

M. Transporting cylinders

1. Move only with a hand truck and with lids fully screwed on.
2. Avoid: rolling or dragging cylinders.
3. Use chains to secure cylinder to the hand truck.
4. Never drop cylinders or allow them to strike each other or other objects sharply.

N. Never attempt to repair or alter cylinders, valves, or Safety relief devices.

O. Cylinders: must not be charged except by the commercial vendor.

P. When tanks are empty, mark the cylinder, "Empty" or "MT". Return all cylinders to the manufacturer or vendor, following departmental procedures.

Q. If a cylinder develops a leak, tighten the valve-packing nut. If the leak persists, move the cylinder outside where it can vent safely. If it is a flammable gas, avoid ignition sources. Promptly notify UW Safety at 766-3277.

XII. Lab Equipment:

A. Equipment common to all laboratories can be hazardous if used improperly.

B. Glassware and Sharps:

1. Inspect: glassware for cracks, scratches, chips or other flaws before use. If in doubt about the Safety of the item, discard it.
2. Damaged items, broken glass and capillary pipettes shall be disposed of in hard-sided, specially marked containers. Do not put glass in open, regular trashcans.
3. When inserting glass tubing into stoppers, lubricate with glycerol or water. Use a slow, twisting motion and either wrap with a towel or wear heavy leather gloves.
4. Ensure: compatibility of chemicals with glass containers.
5. Use only vacuum glassware for vacuum work.
6. Sharps (razor blades, scalpels, syringe needles, broken glass) shall be disposed of in hard-sided, specially marked containers. Do not dispose of sharps in open, regular trashcans. Use blunt-end needles rather than sharp needles whenever possible.
7. Custodians do not dispose of sharps.

C. Centrifuges:

1. Locate the centrifuge in an area where vibrations will not cause bottles or equipment to fall off the counter top.
2. Balance samples each time the centrifuge is used.

3. Keep the lid closed during the entire operation; opening only after the rotor has come to a complete stop.
4. Use only centrifuge tubes rated by the manufacturer to withstand the applied centrifugal force.
5. Stop the centrifuge immediately if an unusual noise or vibration begins.
6. Nitrocellulose tubes:
    a. Do not use if discolored.
    b. Storage at 4^{o}C extends shelf life.
    c. Use only in swinging bucket heads.
    d. Do not autoclave; they could explode.

D. Vacuum Systems:
1. Always wear eye protection (Refer to the Eye Protection Policy).
2. Use only vacuum glassware for vacuum work.
3. Change pressures gradually, in order to not stress the system.
4. Use a trap if there is a potential for drawing water, solvents, corrosives, etc. into the house vacuum or vacuum pump.
5. Vacuum pumps must:
    a. Be vented into a hood.
    b. Be checked for proper oil level and worn belts.
    c. Have belts properly guarded.

E. Unattended Operations:
1. Unattended operations must be approved by the supervisor.
2. It is the operator's responsibility to double check that the equipment is in proper working order before leaving an operation unattended.
3. The responsible operator shall place a sign on the door or near the operation informing other employees of the operation, including names and telephone numbers of those to be contacted in case of an emergency.
4. Support personnel (custodial, security, etc.) may not be requested to collect data or operate equipment.

XIII. First Aid:

A. Immediate first aid is important for overexposure to harmful chemicals.

B. Eye Contact or Skin Contact:
1. Remove contaminated clothing.
2. Flush with water for at least 15 minutes
3. PI/Supervisor shall be notified.

C. Ingestion:

Notify a co-worker and/or the PI/supervisor.

D. Inhalation:

1. Leave the area, securing it if other personnel could be harmed.
2. Notify a co-worker and/or the PI/supervisor.

E. Medical exams or consultations:

Follow procedures: in the Medical Consultation and Exams Section of the Chemical Hygiene Program.

Laboratory Chemicals of Concern

The Chemical Safety Specialist has attempted to provide “lists” of chemicals that are grouped according to their associated hazard. While these lists are comprehensive they are by no means exhaustive. The chemical and physical properties of every chemical encountered in the field needs to be fully understood prior to any manipulation or handling. These documents contain only the names of the compounds and elements by reactivity class. This should insure that users of this information should be compelled to seek more information from the body of available scientific literature. Lists such as those that follow are intended to assist workers who have to obtain a reasonable understanding of the risks that a chemical inventory may present. Perhaps the best approach to accomplishing this is to communicate the chemical categories that present risks so that the potential to “miss” a hazard is minimized. These lists represent chemicals that we believe you will find in chemical inventories, but not every chemical that could be encountered in a chemical inventory and exhibit the properties of concern are present in these lists. Instead at the beginning of each of the attached tables we have incorporated the general categories of chemicals that fit into the respective category of risk.

The presence Shock Sensitive or Pyrophoric Chemicals on one of these lists is not an endorsement or authorization to “blow up” the chemical. For example, Picric Acid is present on these lists but a chemical approach is recommended for its ultimate disposition rather than detonation. The Wyoming DEQ Solid Waste Management Program Regulations found in Chapter 1(h)(3)(C) authorizes the Department to issue and terminate (for cause) Emergency Permits when there is a finding of imminent and substantial endangerment to human health or the environment. This authority may be given orally or in written form. In order to approve an emergency permit it must first be requested.

There are no easy answers in this arena. Be wary of those who believe that anyone with such information can safely deal with the chemistry and physics displayed by these types of chemicals. There is no substitution for good information, relevant experience and caution. Firefighters, hazardous materials workers, police and UW Safety staff who have to contend with emergency situations involving these materials should attempt to secure the best information obtainable through any resource available. Obtain guidance from reputable chemical specialists if available and use conservative operations to protect yourselves, the public’s health and the environment. The materials of greatest concern are those materials that are wastes and have absolutely no value. These valueless wastes are being handled by humans of infinite value and sometimes, at great personal risk.

For the most part responses involving these chemicals are entirely preventable. Persons who have chemicals found on these lists should be acutely aware of safe storage requirements, safe handling procedures, maximum shelf lives and the synergies that may be found in chemicals that populate a laboratory. Persons who have these chemicals need to translate that awareness into preventative measures, inventory control and good chemical hygiene. Realistically in this modern world new workers are constantly moving from employer to employer and older workers retire. These chemicals are left behind through generations of workers until an incident occurs or a level of awareness is obtained.

Compatibility Concerns in Chemical Storage

Chemicals play an important role in many workplace applications. Minimizing the quantity of chemicals on hand can reduce the inherent hazards of chemicals. However, when chemicals must be in-house, proper storage and handling can reduce or eliminate associated risks.

Proper storage information can usually be obtained from the SDS, label or other chemical reference material. An SDS must be on hand for every chemical in your workplace. The SDS and chemical label can be consulted for information on special storage requirements. The SDS can also answer questions such as:

- Is the chemical a flammable or combustible?
- Is the chemical a corrosive?
- Does the chemical need to be stored at other than ambient temperature?
- Is the chemical an oxidizer or reducer?
- Is the chemical light sensitive?
- Does the chemical require any special handling procedures?

Typical storage considerations may include temperature, ignition control, ventilation, segregation and identification. Proper segregation is necessary to prevent incompatible materials from inadvertently coming into contact. If incompatible materials were to come into contact, fire, explosion, violent reactions or toxic gases could result. When segregating chemicals, acids should not be stored with bases, and oxidizers should not be stored with organic materials or reducing agents. A physical barrier and/or distance are effective for proper segregation.

If cabinets are used to segregate chemicals, consider the compatibility of the chemicals with the cabinet. For example, corrosives like strong acids and caustics will corrode most metal cabinets. Non-metallic or epoxy painted cabinets are available and will provide a better service life with these types of chemicals. However, it is recommended that hydrochloric acid not be stored in any metal cabinet. Some other acids and bases may damage the painted surfaces of a cabinet if a spill occurs. Also, Perchloric acid should not be stored in a wooden cabinet.

There are cabinets available specifically for flammable and combustible materials. It is important to be aware of maximum allowable container size and maximum quantities for storage in cabinets based on the class of the flammable. The class of a flammable or combustible is determined by its flash point and boiling point.

For ease of locating chemicals, many storerooms organize chemicals alphabetically. However, chemical storage based upon an alphabetical arrangement of chemicals may inadvertently locate incompatible materials in close proximity.

Chemical Storage Plan for Laboratories

When certain hazardous chemicals are stored or mixed together, violent reactions may occur because the chemicals are unsuitable for mixing, or are incompatible. Classes of incompatible chemicals should be segregated from each other during storage, according to hazard class.

- Chemicals should be stored according to hazard class and categories (ex. flammables, oxidizers, health hazards/toxins, corrosives, etc.).
- Store chemicals away from direct sunlight or localized heat.
- All chemical containers should be properly labeled, dated upon receipt, and dated upon opening.
- Store hazardous chemicals below shoulder height of the shortest person working in the lab.
- Shelves should be painted or covered with chemical-resistant paint or chemical-resistant coating.
- Shelves should be secure and strong enough to hold chemicals being stored on them. Do not overload shelves.
- Personnel should be aware of the hazards associated with all hazardous materials.
- Separate solids from liquids.

Below are examples of chemical groups that can be used to categorize storage. Use these groups as examples when separating chemicals for compatibility. Please note: reactive chemicals must be more closely analyzed since they have a greater potential for violent reactions. Contact UW Safety, Chemical Safety Specialist (766-3277), if you have any questions concerning chemical storage.

Acids:

- Make sure that all acids are stored by compatibility (ex. separate inorganics from organics).
- Store concentrated acids on lower shelves in chemical-resistant trays or in a corrosive's cabinet. This will temporarily contain spills or leaks and protect shelving from residue.
- Separate acids from incompatible materials such as bases, active metals (ex. sodium, magnesium, potassium) and from chemicals, which can generate toxic gases when combined (ex. sodium cyanide and iron sulfide).

Bases:

- Store bases away from acids.
- Store concentrated bases on lower shelves in chemical-resistant trays or in a corrosive's cabinet. This will temporarily contain spills or leaks and protect shelving from residue.

Flammables:

- Approved flammable storage cabinets should be used for flammable liquid storage.
- You may store 20 gallons of flammable liquids per 100 sq.ft. in a properly fire separated lab. The maximum allowable quantity for flammable liquid storage in any size lab is not to exceed 120 gallons.
- You may store up to 10 gallons of flammable liquids outside of approved flammable storage cabinets.
- An additional 25 gallons may be stored outside of an approved storage cabinet if it is stored in approved Safety cans not to exceed 2 gallons in size.

- Use only explosion-proof or intrinsically safe refrigerators and freezers for storing flammable liquids.
- University of Wyoming guidelines for flammable storage follow NFPA 30, 45 and the UW Safety Manual.

Peroxide-Forming Chemicals:

- Peroxide-forming chemicals should be stored in airtight containers in a dark, cool, and dry place.
- Unstable chemicals such as peroxide-formers must always be labeled with date received, date opened, and disposal/expiration date.
- Peroxide-forming chemicals should be properly disposed of before the date of expected peroxide formation (typically 6-12 months after opening).
- Suspicion of peroxide contamination should be immediately investigated. Contact Chemical Safety Specialist for procedures.

Water-Reactive Chemicals:

- Water reactive chemicals should be stored in a cool, dry place.
- Do not store water reactive chemicals under sinks or near water baths.
- Class D fire extinguishers for the specific water reactive chemical being stored should be made available.

Oxidizers:

- Make sure that all oxidizers are stored by compatibility.
- Store oxidizers away from flammables, combustibles, and reducing agents.

Toxins:

- Toxic compounds should be stored according to the nature of the chemical, with appropriate security employed when necessary.
- A "Poison Control Network" telephone number should be posted in the laboratory where toxins are stored (800-222-1222).

Color Coded Labeling Systems That May Be Found In Your Lab:

Hazard	Color Code
Flammables	**Red**
Health Hazards/Toxins	**Blue**
Reactives/Oxidizers	**Yellow**
Contact Hazards	**White**
General Storage	**Gray, Green, Orange**

Please Note: Chemicals with labels that are colored and striped may react with other chemicals in the same hazard class. See SDS for more information. Chemical containers, which are not color-coded, should have hazard information on the label. Read the label carefully and store accordingly.

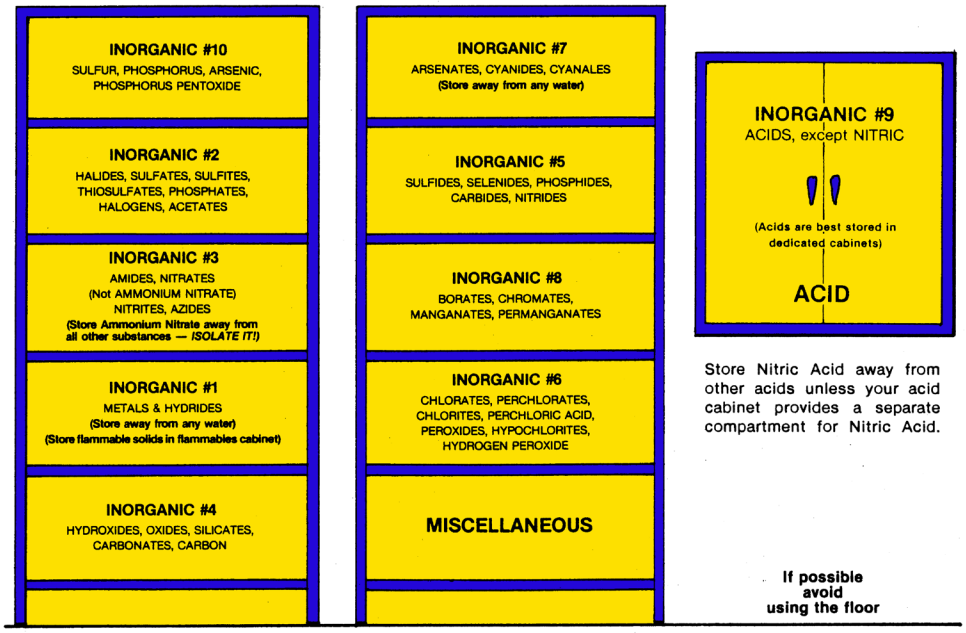
Suggested storage plan of inorganics and organics, Figure 1

National Safety Council Storage Arrangement of chemicals by family and compatible groups.

List of chemical families and specific chemicals: that are incompatible with each other, Chemical Incompatibility.

Figure 1

SUGGESTED SHELF STORAGE PATTERN — INORGANIC



SUGGESTED SHELF STORAGE PATERN — ORGANIC

National Safety Council Storage Arrangement of chemicals by family and compatible groups.

Inorganic Family

- Metal hydrides
- Halides, sulfates, sulfites, thiosulfates, phosphates, halogens
- Amides, nitrates (e.g. Ammonium nitrate), nitrites, azides
- Hydroxides, oxides, silicates, carbonates, carbon
- Sulfides, selenides, phosphides, carbides, nitrides
- Chlorates, perchlorates, perchloric acid, chlorites, hypochlorites, peroxides
- Arsenates, cyanides, cyanates
- Borates, chromates, manganates, permanganates
- Nitric acid and other inorganic acids

Organic Family

- Acids, anhydrides, peracids
- Alcohols, glycol, amines, amides, imines, imides
- Hydrocarbons, esters, aldehydes
- Epoxy compounds, isocyanates
- Peroxides, hydroperoxides, azides
- Sulfides, polysulfides, sulfoxides, nitrites
- Phenols, cresols

Chemical Incompatibility

A	Incompatible with	B
Alkali and Alkaline earth metals		Water
Carbides		Acids
Hydrides		Halogenated organics
Hydroxides		Halogenating reagents
Metals		Oxidizing agents
Peroxides		Oxidizing agents
Azides (inorganic)		Acids, Heavy metals, Oxidizing agents
Cyanides (inorganic)		Acids, Strong bases
Nitrates (inorganic)		Acids, Reducing agents
Nitrites (inorganic)		Acids, Oxidizing agents
Organic compounds		Oxidizing agents
Organic acyl halides and Organic anhydrides		Bases, Organic hydroxides and amino
Organic halogens		Group IA and IIA Metals, aluminum
Organic nitro compounds		Strong bases

A	Incompatible with	B
Oxidizing agents		**Reducing agents**
Chlorates		Ammonia, anhydrous and aqueous
Chromates		Carbon
Chromium trioxide		Metals
Dichromates		Metal hydrides
Halogens		Nitrites
Halogenating agents		Organic compounds
Hydrogen peroxide		Phosphorus
Nitric acid		Silicon
Perchlorates		Sulfur
Peroxides		
Permanganate		
Persulfates		

A	Incompatible with	B
Reducing agents		**Oxidizing agents**
		Arsenates
		Arsenites
		Phosphorus
		Selenites
		Selenates
		Tellurium salts and oxides
Sulfides, inorganic		**Acids**

Specific Incompatible Chemicals

Acetic Acid	Chromic acid, nitric acid, peroxides, permanganates, perchloric acid
Acetic anhydride	Water, hydroxyl containing compounds (glycols), perchloric acid
Acetone	Nitric acid, sulfuric acid mixtures, hydrogen peroxide
Acetylene	Chlorine, bromine, copper, silver, fluorine, mercury
Alkali / alkaline earth metals	Carbon dioxide, chlorinated hydrocarbons, water
Ammonia (anhydrous)	Mercury, chlorine, hypochlorites, Iodine, bromine, hydrogen fluoride
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, combustibles
Aniline	Nitric acid, hydrogen peroxide
Bromine	Ammonia, acetylene, butadiene, petroleum gases, carbides, organics, powdered metals
Calcium oxide	Water
Carbon, activated	Oxidants
Chlorates	Ammonium salts, acids, metal powders, organics, combustibles
Chromic acid chromium trioxide	Acetic acid, flammable liquids, combustibles
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Fluorine	Isolate from everything
Hydrazine	Oxidizers
Hydrocarbons	Halogens, oxidizers
Hydrocyanic acid	Acids, and strong alkalis
Hydrofluoric acid-Hydrogen fluoride	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Most metals and their salts, flammables and combustibles, aniline, nitromethane
Hydrogen sulfide	Acids, oxidizers
Iodine	Acetylene, ammonia (aqueous or anhydrous)
Mercury	Acetylene, nitric acid-ethanol mixtures, ammonia
Nitric acid (conc.)	Combustible acids (acetic and phosphoric), flammables, nitratable substances, aniline, hydrogen cyanide, hydrogen sulfide, chromic acid, metals
Nitroparaffins	Inorganic bases, amines

Oxalic acid	Silver, mercury and their salts
Oxygen	Hydrogen, oils, grease, flammables
Perchloric acid	Organics, metals and their salts
Peroxides, organic	Acids (organic and mineral), store cold, avoid friction
Phosphorus, white	Air, oxygen
Phosphorus pentoxide	Alcohols, strong bases, water
Potassium chlorate	Acids (see Chlorates)
Potassium perchlorate	Acids (see perchloric acid)
Potassium permanganate	Glycerol, glycols, benzaldehyde, sulfuric acid
Silver and silver salts	Acetylene, oxalic acid, tartaric acid, nitric acid-ethanol mixtures, ammonium compounds
Sodium	See alkali metals
Sodium nitrite	Ammonium nitrate and ammonium salts
Sodium peroxide	Oxidizable substances, water
Sulfuric acid	Chlorates, perchlorates, permanganates

References:

1. Safety in Academic Laboratories, American Chemical Society, 1988
2. Prudent Practices in the Laboratory, National Safety Council, 1995
3. 29 CFR 1910.119 Appendix A. List of Highly Hazardous Chemicals, Toxics, and Reactives, OSHA, 2000
4. 6 CCR 1007-3 261.21, 261.22,261.23 Characteristics of Hazardous Waste
5. 49 CFR 172.101 Hazardous Materials Table, USDOT, 2000
6. Handbook of Reactive Chemical Hazards, Bretherick, L and Urben, P.G., 6th Edition, 1999, Vol. 1 and 2
7. Dangerous Properties of Industrial Materials, Lewis and Sax, 9th Edition, 1996
8. Toxicological, Occupational, Medical, and Environmental Database, Micromedix, On-line version, 2000
9. 49 CFR 173.52 Classification codes and compatibility groups of explosives. USDOT, 2000
10. 49 CFR 173.54 Forbidden explosives. USDOT, 2000

GENERAL LABORATORY HAZARDS AND EQUIPMENT SAFETY

SAFETY = INFORMATION + AWARENESS + PRECAUTIONS

- **Physical Hazards**

  Slips, trips and falls are one of the most common problems on campus. They can result from wet floors, junk in passageways, and heels getting caught in stairs or equipment. Lifting of heavy equipment or furniture strains backs. Strained backs are hard to treat, take a long time to heal (if ever) and are susceptible to re-injury. Repetitive motion is becoming a growing problem in laboratories. Fingers and wrists are at special risk from pipetting.

- **Electrical Hazards**

  Several fires on campus have resulted from laboratory personnel performing their own electrical wiring. The electronic shop and the electricians at Physical Plant should be consulted on any wiring job. As labs become crowded, overloading of power strips is frequently seen and these can cause fires. Outlets next to sinks and/or faucets run the potential of carrying currents to the plumbing or electrocuting someone at the sink.

- **Pressure Hazards**

  High pressure can result in explosions and shrapnel. Implosions from vacuum systems can result in broken glass. Release of even inert gases can cause asphyxiation by displacement of oxygen. Gas cylinders not only have pressurization hazards, but present the chemical hazards, too.

- **Thermal Hazards**

  Heat can be found in hot equipment, hot glassware and open fires. Cryogenics present the same physiological danger. The first aid for both is cold water.

- **Noise Hazards**

  There are many pieces of loud equipment, e.g. grinders and sonicators. Hearing protection takes the form of earmuffs, ear inserts or simply moving a distance from the noise source.

- **Hazardous Waste**

  Hazardous Waste holds the same dangers as the chemicals before becoming a waste. There is a proactive way of preventing the hazards to the employee and the environment: waste minimization. If hazardous waste can be reduced at the source, it presents a financial and health and environmental bonus.

- **Safety Equipment:**
  - Fume Hoods
  - Fire Extinguishers
  - Eye Washes
  - Emergency Showers

- **Personal Protective Equipment - PPE**

  As many hazards as possible have been taken care of with engineering controls (such as ventilation and fume hoods) to minimize the risk to employees. Another level of protection is added with PPE. PPE provides a barrier between the individual employee and the hazard. Yet, even experienced employees can fail to adequately protect themselves by using insufficient or inappropriate PPE.

  - Eye Protection
  - Gloves
  - Clothing

Safety Guidelines for Pregnant Women in the Laboratory

Introduction

Exposure to hazardous materials (chemicals, biologicals, radioactive materials) in laboratories can pose harm to not only pregnant women, but also to their unborn children. If a pregnant woman is working with radioactive materials, and she decides to declare herself pregnant, she should call the Radiation Safety Officer (ext. 6-3277) for proper monitoring. Hazardous materials may cross the placental barrier and some may affect the proper development of the pre-born infant. The most vulnerable time period for the fetus is the first trimester of the pregnancy. During this time, the foundation for all the organs is developed and the bodily functions formed. Hazardous materials cause harm to the body when they enter the body. Four routes of entry are recognized: inhalation, absorption, ingestion and injection. Once a hazardous material has entered the body, it cannot be easily removed. During that time the damage has begun.

The mother may choose to protect herself and her baby by utilizing safety precautions that have been developed for the laboratory. The following general guidelines protect all laboratory employees' health. If followed faithfully, they also minimize exposure to the developing fetus.

Information

Knowledge of the specific hazards presented by the material used is critical in assessing the type of protection needed. Information for the hazardous material may be found in SDSs, labels, literature, from UW Safety (766-3277) or from the instructor for the class. All employees, including pregnant women, are encouraged to make use of these sources of information. Find a list of Reproductive Hazards.

Inhalation Hazards

Inhalation, or breathing, the hazardous material in the air allows it to enter the respiratory tract where the gases can be exchanged into the circulatory system. Laboratories are designed with the recommended rate of air exchange to remove contaminated air. Hazardous materials should only be opened and handled in a fume hood or biological safety cabinet, as appropriate, to ensure that the contaminated air is moved away from the breathing zone of the laboratory worker.

Absorption Hazards

Some materials can be absorbed directly through the skin to the circulatory system. Although not all hazardous materials have this property, most hazardous materials have not been studied sufficiently to know whether they absorb through the skin or not. Therefore, when handling any hazardous material, a barrier should be worn to prevent contact with the skin. Gloves that are

impervious to the material, eye protection, and lab coats should always be worn when handling hazardous materials. If the information on the chemical recommends the use of further protection, additional personal protective equipment should be utilized. If hazardous materials are spilled on the skin, the skin should be washed with soap and water for a minimum of 15 minutes. If clothes are contaminated with the hazardous materials, they should be removed immediately.

Ingestion Hazards

Accidental ingestion of hazardous materials through contaminated hands or food or drink put the materials into the digestive tract where they can be further delivered to the circulatory system. Eating, drinking and smoking are prohibited in all UW laboratories to prevent this route of entry for hazardous materials. It is further recommended that hands be washed with soap and water after handling hazardous materials (even if the hands wore gloves) and before leaving the laboratory.

Injection Hazards

Injection of hazardous materials through broken skin, even if it is just chapped skin, can deliver hazardous materials to the circulatory system. Glassware should be inspected before use to look for cracks or chips. Broken glass should be handled only with tongs or a broom, not fingers. The use of gloves will provide a barrier for broken skin on the hands. Syringe needles should never be recapped; they should be directly disposed to a sharp's container.

Partial List of Reproductive Hazards

This list is provided as a guide and is not all-inclusive.
Carefully review of material Safety data sheets before working with chemicals.

CHEMICALS

acetaldehyde
acrylicacid
aflatoxins
aniline
arsenic
benzene
benzo(a)pyrene
cadmium
carbon disulfide
chromic acid
chloroform
chloroprene
N,N-dimethylacetamide
dimethylformamide (DMF)
dimethyl sulfoxide (DMSO)
dinitrooctylphenol
di-sec-octyl-phthalate
diphenylamine
dithane
estradiol
2-ethoxyl ethanol
2-ethoxyetyl acetate
ethyl thiourea
2-ethylhexanol
formaldehyde
formamide
glycol ethers
halothane
hexachlorobenzene
hexafluoroacetone
hydrazine(s)
iodoacetic acid
karathane
lead compounds
mercury compounds
2-methoxy ethanol
2-methoxy ethylacetate
methylchloride
N-methyl-2-pyrolidone
nitrobenzene
nitrous oxide
phenol
polychlorinated and polybrominated biphenyls
propylene glycol monomethyl ether

propylene glycol monomethyl ether acetate
propylene oxide
systhane
TOK (herbicide)
toluene
trichloroethylene
vinyl chloride
xylene

RADIATION
Therapeutic Radioiodine
Atomic Weapons

DRUGS AND ENVIRONMENTAL CHEMICALS
Androgenic hormones
Aminopterin and methylaminopterin
Busulfan
Chlorobiphenyls
Coumarin anticoagulants
Cyclophosphamide
Diethylstibestrol
Diphenylhydantoin
Goitrogens and antithyroid drugs
Lithium
Methimazole
Penicillamine
13-cis-retinoic acid (Isotretinoin,Accutane)
Tetracyclines
Thalidomide
Trimethadione and paramethadione
Valproic acid

INFECTIONS
Rubella virus
Cytomegalovirus
Herpes simplex virus I and II
Toxoplasmosis
Venezuelan equine encephalitis virus
Syphillis

MATERNAL METABOLIC IMBALANCE
Endemic cretinism
Diabetes
Phenylketonuria
Virilizing tumors and metabolic conditions
Alcoholism
Hyperthermia
Rheumatic disease and congenital heart block

POSSIBLE TERATOGENS
Cigarette smoking
Diazepam (Valium)
Zinc deficiency
High Vitamin A
Varicella
Binge drinking
Organic solvents (laboratory workers)

UNLIKELY TERATOGENS
Aspirin
Birth control pills
Ultrasound
Spermicides
Bendectin (antinauseants)
Illicit drugs (marihuana, LSD, cocaine)
Videodisplay terminals
Aspartame
Anesthetics
Rubella vaccine
Metronidazole

Partial List of Pyrophoric Chemicals

Grignard reagents,	RMgX
Metal alkyls and aryls, such as	RLi, RNa, R3Al, R2Zn
Metal carbonyls, such as	Ni(CO)4, Fe(CO)5, Co2(CO)8
Alkali metals such as	Na, K
Metal powders, such as	Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr
Metal hydrides, such as	NaH, LiAlH4
Nonmetal hydrides, such as	B2H6 and other boranes, PH3, AsH3
Nonmetal alkyls, such as	R3B, R3P, R3As
Phosphorus (white)	

Partial List of Shock Sensitive Chemicals

This reactivity is typically described as "shock, or impact sensitivity". There are other initiating mechanisms for these compounds Consult the available literature regarding these chemicals.

Acetyl azide	Chloropicrin
Acetyl nitrate	Copper acetylide
Ammonium nitrate	Cyanuric triazide
Ammonium azide	Diazidoethane
Ammonium bromate	Diazomethane
Ammonium chlorate	Diazodinitrophenol
Ammonium dichromate	Dinitrophenol
Ammonium hexanitrocobaltate	Dinitrophenylhydrazlne
Ammonium nitrate	Diethylene glycol dinitrate
Ammonium nitrite	Dipentaerithritol hexanitrate
Ammonium periodate	Dipicryl amine
Ammonium permanganate	Disulfur dinitride
Ammonium picrate	Ethyl nitrite
Ammonium tetraperoxychromate	Fluorine azide
Azidocarbonyl guanidine	Glycol dinitrate
Barium azide	Glycol monolactate trinitrate
Barium chlorate	Guanyl nitrosaminoguanyl hydrazine
Benzene diazonium chloride	HMX
Benzotriazole	Hydrazoic acid
Benzoyl peroxide	Hydrazine azide
Bismith nitrate	Lead azide
Boron triazide	Lead dinitrorescorcinate (Styphnate)
Butenetroil trinitrate	Lead mononitrorescorcinate
t-butyl Hypochlorite	Mannitol hexanitrate
Cadmium azide	Lithium nitrate
Cadmium chlorate	Lithium nitride
Cadmium hexamine chlorate	Lithium peroxide
Cadmium hexamine perchlorate	Mercuric oxycyanide

Cadmium nitrate	Mercury oxalate
Cadmium nitride	Mercury fulminate
Cadmium trihydrazine chlorate	Nitroglycerin
Calcium nitrate	Nitrosoguanidine
Calcium permanganate	Pentaerythritol tetranitrate (PETN)
Cesium azide	Perchloric acid
Chlorine dioxide	Picramlde and metal picrates
Chlorine trioxide	Picric acid, Picrates, Picryl cmpds
Chloroacetylene	Picryl hydrazyl

Partial List of Shock Sensitive Chemicals (con't)

Polyvinyl nitrate
Potassium chlorate
Potassium dinitrobenzfuroxan
Potassium nitrate
Potassium peroxide and Superoxide
RDX
Silver acetylide
Silver azide
Silver dinitrorescorcinate (Styphnate)
Silver fulminate
Silver nitride
Silver oxalate
Silver tetrazene
Sodium azide
Sodium chlorate
Sodium chlorite
Sodium nitrate
Sodium perchlorate
Sodium perborate and monohydrate
Sodium peroxide
Sodium picramate
Sodium Superoxide
Strontium chlorate
Strontium nitrate
Strontium perchlorate
Tetranitromethane
Tetraselenium tetranitride
Tetrazene
Tetryl
Thallium nitride
Trilead dinitride
Trinitroanisole
Trinitrobenzene

Trinitrobenzoic acid
m-Trinitrocresol
Trinitronaphthalene
Trinitroresorcinol
Trinitrotoluene
Urea nitrate
Vinyl azide
Zinc peroxide

Safe Use of Perchloric Acid

Perchloric acid is a very strong oxidizing agent, often used for the hot digestion of a variety of materials. Perchloric acid as used in the cold, dilute form in certain biochemical protocols is relatively safe. It can cause violent explosions if misused or when concentrated above the normal commercial strength of 72%. Anhydrous Perchloric acid should never be prepared as it is unstable at room temperature and will decompose with a violent explosion. The following rules for the hot use of Perchloric acid must be followed at all times:

- Hot Perchloric acid work may only be conducted in a rated Perchloric acid hood or, under special, well-controlled circumstances, with a high efficiency scrubber.
- A Perchloric acid hood must be washed down after every use or once per week, whichever comes first.
- Do not store or use organic materials, such as solvents, in a Perchloric acid use hood.
- If a vacuum is needed for Perchloric acid work use a water aspirator rather than a mechanical pump. Perchloric acid contact with hydrocarbon-based oils or greases in a conventional mechanical vacuum pump may result in an explosion.
- Use the minimum amount of material possible.
- Purchase the smallest quantity available for your needs.
- Store Perchloric acid away from all oxidizable materials using secondary containment.
- All containers of Perchloric acid in storage must be inspected frequently. Discolored Perchloric acid is dangerous and must be disposed of at once.
- Do not use or store Perchloric acid on wooden lab furniture or cracker or porous bench top materials.
- When possible, use alternative techniques not requiring Perchloric acid.
- Do not attempt to clean up spills of concentrated Perchloric acid yourself as contact with oxidizable materials can cause an immediate explosion. If you spill Perchloric acid call 911 and UW Safety will respond to clean up the spill.

References:

Prudent Practices in the Laboratory, National Research Council, 1995.

CRC Handbook of Laboratory Safety, 3rd Ed., CRC Press, 1990.

Peroxide Forming Chemicals

Many liquid organic compounds, a few solid and gaseous organic compounds and a few inorganic solids form peroxides upon storage. Most organic peroxides are sensitive to shock, heat or friction to varying degrees. These compounds form by the reaction of the chemical with oxygen allowed in the headspace of chemical containers once the container is opened for the first time. Peroxides form at varying rates depending upon the compound. Some peroxides quickly build up to an explosive level and some are only explosive on concentration, such as when a solvent is distilled. Although there is no agreement upon what level of peroxides present a significant hazard, several sources suggest that the "safe" range of peroxide formation is **100 ppm** or less. We recommend that all peroxide forming chemicals be tested at the end of the appropriate storage period (see below). If peroxides are detected at a level above 100 ppm, the material must be decontaminated with standard procedures for de-peroxidation or discarded as hazardous waste if the material cannot be drain disposed. Test strips for the detection of peroxides may be purchased from the A&S Chemistry stockroom in the basement of the Physical Science Building or lab supply houses. Several chemical methods for the detection of peroxides are also available.

General categories of compounds known to auto-oxidize to form peroxides:

- Aldehydes
- Ketones (especially cyclic ketones)
- Ethers (especially cyclic and those containing primary and secondary alkyl groups)
- Compounds containing allylic hydrogens (e.g. alkenes, vinyl and vinylidiene compounds)
- Compounds that contain Benzylic hydrogens
- Compounds containing a tertiary C-H group (e.g., decalin and 2,5-dimethylhexane)
- Alkali metals and alkali metal amides

Control and Safe Use of Peroxide Formers

Peroxide formation may be controlled by the following methods:

- Date all incoming containers of peroxide formers when received and again when opened. Many chemical companies now routinely print an expiration date on containers of the worst peroxide formers.
- Purchase the smallest possible container size for your needs.
- Store peroxide formers in sealed, air-impermeable containers such as dark amber glass with a tight-fitting cap.
- Iron inhibits the formation of peroxides in some materials, which is why diethyl ether and some other materials are purchased in metal cans. Ground glass stoppered bottles and plastic containers are not advisable, however, plastic squeeze bottles may be used for small quantities of some materials, such as 2-propanol, for immediate use.
- Store peroxide formers in the dark.
- Inhibitors are added to some chemicals and the purchase of peroxide formers with added inhibitors is encouraged.
- Store peroxide formers, especially those in Table A below, under nitrogen or other inert gas or keep and use them in an inert atmosphere chamber. Note: Some inhibitors actually need small amounts of oxygen to prevent peroxide formation and it is recommended that inhibited chemicals are not stored under an inert atmosphere.
- Avoid the distillation of peroxide formers without first testing for the existence of peroxides

in the material. Most explosions with the use of peroxide formers occur when a material is distilled to dryness. Leave at least 10-20% bottoms. Stir such distillations with a mechanical stirrer or an inert gas. Air or an oxygen containing mixture should never be used for this purpose.

Testing for Peroxides

Routine testing done with commercial test strips, or using potassium iodide (100 mg/1 mL g. Acetic acid + 1 mL of solvent) show three categories of results:

0-30 ppm: Little or no threat of violent reaction. Should be stabilized with hydroquinone, t-butyl catechol or ferrous sulfate. (KI test slightly yellow)

30-80 ppm: Expired or mismanaged compounds that **may** pose a threat to persons and structures. The available literature shows that attempts to stabilize these compounds may initiate exothermic reactions that may pose a threat to persons and structures. (KI test brilliant yellow)

Greater than 80 ppm: Expired or mismanaged compounds **that** pose a threat to persons and structures. (KI test brilliant yellow to red)

Safe Storage Periods for Peroxide Formers

Twelve-month storage limit: Twelve-month test cycle will be completed unless the reagent is stabilized, such as, HPLC grade ethers. Special handling and accountability Is required for uninhibited reagents. These compounds form peroxides with age. Exposure to air is necessary for peroxide formation. Light promotes peroxide formation in the presence of oxygen. Manage containers to minimize headspace or inert container contents. Do not attempt to test containers outside of safe storage limits. Concentration of peroxides by distillation or evaporation is typically necessary for explosivity. However, concentrations of peroxides that have caused crystallization or have phase separation are extremely dangerous:

Unopened chemicals from manufacturer:	18 months
Opened containers:	
Chemicals in Class III.	3 months
Chemicals in Classes II and IV.	12 months
Uninhibited chemicals in Class I.	24 hours
Inhibited chemicals in Class I.	12 months

(Do not store under an inert atmosphere)

Removal of Peroxides or Destruction of Diacyl and Dialkyl Peroxides

Peroxides can be removed from a solvent by passing it through a column of basic activated alumina, by treating it with indicating Molecular Sieves®, or by reduction with ferrous sulfate. Although these procedures remove hydroperoxides, which are the principal hazardous contaminants of peroxide-forming solvents, they do not remove dialkyl peroxides, which may also be present in low concentrations. The following procedures are found in “Prudent Practices in the Laboratory”: Handling and Disposal of Chemicals, 7.D.2.5.

Removal of peroxides with alumina:

A 2 x 33 cm column filled with 80 g of 80-mesh basic activated alumina is usually sufficient to

remove all peroxides from 100 to 400 mL of solvent, whether water-soluble or water-insoluble. After passage through the column, the solvent should be tested for peroxide content. Peroxides formed by air oxidation are usually decomposed by alumina, not merely absorbed on it. However, for Safety it is best to slurry the wet alumina with a dilute acidic solution of ferrous sulfate before it is discarded.

Removal of peroxides with Molecular Sieves®:

Reflux 100 mL of solvent with 5 g of 4- to 8- mesh indicating activated 4A Molecular Sieves® for several hours under nitrogen. The sieves are separated from the solvent and require no further treatment because the peroxides are destroyed during their interaction with the sieves.

Removal of peroxides with ferrous sulfate:

$$\mathbf{ROOH + 2Fe^{2+} + 2H^{+} \rightarrow ROH + 2Fe^{3+} + H_2O}$$

A solution of 6 g of $FeSO_4 \cdot 7H^2O$, 6 mL of concentrated sulfuric acid, and 11 mL of water is stirred with 1L of water-insoluble solvent until the solvent no longer gives a positive test for peroxides. Usually only a few minutes are required.

Procedure for destruction of diacyl peroxides:

Diacyl peroxides can be destroyed by this reagent as well as by aqueous sodium hydrogen sulfite, sodium hydroxide, or ammonia. However, diacyl peroxides with low solubility in water, such as dibenzoyl peroxide, react very slowly. A better reagent is a solution of sodium iodide or potassium iodide in glacial acetic acid.

$$(RCO_2)_2 + 2NaI \rightarrow 2RCO_2Na + I_2$$

Classes of Peroxides and Partial List of Chemicals

Class I: Unsaturated materials, especially those of low molecular weight, may auto-polymerize violently and hazardously due to peroxide initiation. Test for peroxide formation or discard liquids after 6 months; discard gases after 1 year.

Acrylic acid[b]
Acrylonitrile[b]
Butadiene[c]
Chlorobutadiene (Chloroprene)[c]
Chlorotrifluoroethylene
Methyl methacrylate[b]
Styrene
Tetrafluoroethylene[c]
Vinyl acetate
Vinyl acetylene
Vinyl chloride
Vinyl pyridine
Vinylidine chloride

Class II: The following chemicals are a peroxide hazard upon concentration (distillation / evaporation). A test for peroxide should be performed if concentration is intended or suspected. Test for peroxide formation or discard after 1 year.

Acetal
Acetaldehyde
Acrolein
Alcohols (primary, secondary)
Alcohols (allylic, benzylic)
Alkly-substituted cycloaliphatics
Benzyl alcohol
2-Butanol
Cumene
Cycloheptanone
Cyclohexanol
Cyclohexanone
2-Cyclohexen-1-ol
Cyclohexene
Cyclopentene
Cyclopentanone
Decahydronaphthalene
Diacetylene
Dicyclopentadiene
Diethylene glycol dimethyl ether (Diglyme)
Diethyl ether
Dioxane (p-dioxane)
Ethylene glycol dimethyl ether (Glyme)
Furan
Grignard reagents (ether solvents)
4-Heptanol
2-Hexanol
Methyl acetylene
3-Methyl-1-butanol
Methyl cyclopentane
Methyl isobutyl ketone (MIBK)
4-Methyl-2-pentanol
2-Pentanol
4-Penten-1-ol
1-Phenylethanol
2-Phenylethanol
2-Propanol
Tetrahydrofuran
Tetrahydronaphthalene
Vinyl ethers

Class III: Peroxides derived from the following compounds may explode without concentration.

There will be a three ***(3)*** month storage limit for the following chemicals and there these chemicals **Must be stabilized,** tested or discarded.

Organic cmpds:	**Inorganic cmpds:**
Butadiene[a]	Potassium metal
Chloroprene[a]	Potassium amide
Divinyl ether	Sodium amide (Sodamide)
Divinyl acetylene	
Isopropyl ether	
Tetrafluoroethylene[a]	
Vinylidene chloride (1,1-DCE)	

Class IV: Chemicals that may form peroxides but cannot clearly be placed in Classes I, II, or III.

Acrolein	*B*-Bromophenetole
Allyl ether[d]	*o*-Bromophenetole
Allyl ethyl ether	*p*-Bromophenetole
Allyl phenyl ether	3-Bromopropyl phenyl ether
p-(*n*-Amyloxy)benzoyl chloride	1,3-Butadiyne
n-Amyl ether	Buten-3-yne
Benzyl *n*-butyl ether[d]	*tert*--Butyl ethyl ether
Benxyl ether[d]	*tert*-Butyl methyl ether
Benzyl ethyl ether[d]	*n*-Butyl phenyl ether
Benzyl methyl ether	*n*-Butyl vinyl ether
Benzyl 1-napthyl ether[d]	Chloroacetaldehyde diethylacetal[d]
1,2-Bis(2-chloroethoxy) -ethane	2-Chlorobutadiene
Bis(2 ethoxyethyl)ether	1-(2-Chloroethoxy)-2-phenoxyethane
Bis(2(methoxyethoxy)-ethyl) ether	Chloroethylene
Bis(2-chloroethyl) ether	Chloromethyl methyl ether[e]
Bis(2-ethoxyethyl) adipate	B-Chlorophenetole
Bis(2-ethoxyethyl) phthalate	o-Chlorophenetole
Bis(2-methoxyethyl) carbonate	p-Chlorophenetole
Bis(2-methoxyethyl) ether	Cyclooctene[d]
Bis(2-methoxyethyl) phthalate	Cyclopropyl methyl ether
Bis(2-methoxymethyl) adipate	Diallyl ether[d]
Bis(2-n-butoxyethyl) phthalate	*p*-Di-n-butoxybenzene
Bis(2-phenoxyethyl) ether	1,2-Dibenzyloxyethane[d]
Bis(4-chlorobutyl) ether	*p*-Dibenzyloxybenzene[d]
Bis(chloromethyl) ether[e]	1,2-Dichloroethyl ethyl ether
2-Bromomethyl ethyl ether	2,4-Dichlorophenetole

Class IV (con't)

Diethoxymethane[d]	Limonene
2,2-Diethoxypropane	1,5-*p*-Methadiene
Diethyl ethoxymethylene-malonate	Methyl *p*-(*n*-amyloxy)benzoate
Diethyl fumarate[d]	4-Methyl-2-pentanone
Diethyl acetal[d]	*n*-Methylphenetole
Diethylketene[f]	2-Methyltetra-hydrofuran
m,o,p-diethoxybenzene	3-Methoxy-1-butyl acetate
1,2-Diethoxyethane	2-Methoxy-ethanol
Dimethoxymethane[d]	3-Methoxyethyl acetate
1,1-Dimethoxyethane[d]	2-Methoxyethyl vinyl ether
Dimethylketene[f]	Methonxy-1,3,5,7-cyclooctatetraene
3,3-Dimethoxypropene	B-Methoxy-propionitrile
2,4-Dinitrophenetole	m-Nitro-phenetole
1,3-Dioxepane[d]	1-Octene
Di(1-propynyl)ether[f]	Oxybis(2-ethyl acetate)
Di(2-propynyl)ether	Oxybis(2-ethyl benzoate)
Di-*n*-propoxymethane[d]	*B,B*-oxydi-propionitrile
1,2-Epoxy-3-isopropoxypropane[d]	1-Pentene
1,2-Epoxy-3-phenoxypropane	Phenoxyacetyl chloride
p-Ethoxyacetho-phenone	*a*-Phenoxy-propionyl chloride
1-(2-Ethoxyethoxy)-ethyl acetate	Phenyl *o*-propyl ether
2-Ethoxyethyl acetate	*p*-Phenylphenetone
(2-Ethoxyethyl)-o-benzoyl benzoate	*n*-Propyl ether
1-Ethoxynaphthalene	*n*-Propyl isopropyl ether
o,p-Ethoxyphenyl isocyanate	Sodium 8,11,14-eicosa-tetraenoate
1-Ethoxy-2-propyne	Sodium ethoxyacetylide[f]
3-Ethoxyopropionitrile	Tetrahydropyran
2-Ethylacrylaldehyde oxime	Triethylene glycol diacetate
2-Ethylbutanol	Triethylene glycol dipropionate
Ethyl *B*-ethoxy-propionate	1,3,3-Trimethoxy-propene[d]
2-Ethylhexanal	1,1,2,3-Tetrachloro-1,3-butadiene
Ethyl vinyl ether	4-Vinyl cyclohexene
2,5-Hexadiyn-1-ol	Vinylene carbonate
4,5-Hexadien-2-yn-1-ol	
n-Hexyl ether	
o,p-Iodophenetole	
Isoamyl benzyl ether[d]	
Isoamyl ether[d]	
Isobutyl vinyl ether	
Isophorone[d]	
B-Isopropoxy-propionitrile[d]	
Isopropyl 2,4,5-tri-chlorophenoxyacetate	

NOTES:

[a] When stored as a liquid monomer.

[b] Although these chemicals form peroxides, no explosions involving these monomers have been reported.

[c] When stored in liquid form, these chemicals form explosive levels of peroxides without concentration. They may also be stored as a gas in gas cylinders. When stored as a gas, these chemicals may auto-polymerize as a result of peroxide accumulation.

[d] These chemicals easily form peroxides and should probably be considered under Class II.

[e] OSHA - regulated carcinogen.

[f] Extremely reactive and unstable compound.

References:

Prudent Practices in the Laboratory, National Research Council, 1995.

"Review of Safety Guidelines for Peroxidizable Organic Chemicals," Chemical Health and Safety, September/October 1996.

Partial List of Water Reactive Chemicals

Acetic anhydride	n-butyl Lithium
Acetyl halides	n-butyl Trichlorosilane
Alkyl aluminum chloride	Cadmium acetylide
Allyl trichlorosilane	Cadmium amide
Aluminum aminoborohydride	Calcium
Aluminum borohydride	Calcium carbide
Aluminum bromide	Calcium hydride
Aluminum chloride	Calcium oxide
Aluminum fluoride	Calcium phosphide
Aluminum hydrophosphide	Cesium amide
Aluminum phosphide	Cesium hydride
Aluminum tetrahydroborate	Cesium phosphide
Amyl trichlorosilane	Chlorine dioxide
Anisoyl chloride	Chlorine monofluoride
Antimony tribromide	Chlorine pentafluoride
Antimony trichloride	Chlorine trifluoride
Antimony trifluoride	Chloroacetyl chloride
Antimony triiodide	Chlorodiisobutyl aluminum
Barium	Chlorophenyl isocyanate
Barium peroxide	Chromyl chloride
Barium carbide	Copper acetylide
Barium sulfide	Cyclohexenyl trichlorosilane
Benzene phosphorus dichloride	Cyclohexyl trichlorosilane
Benzyl chloride	Decarborane
Benzyl silane	Diborane
Benzyl sodium	Diethyl aluminum chloride

Beryllium hydride	Diethyl dichlorosilane
Beryllium tetrahydroborate	Diethyl zinc
Bismuth pentafluoride	Diisopropyl beryllium
Borane (and boranes)	Dimethyl dichlorosilane
Boron bromodiiodide	Dimethyl magnesium
Boron dibromoiodide	Diphenyl dichlorosilane
Boron phosphide	Diphenyl diisocyanate
Boron tribromide	Disulfuryl chloride
Boron trichloride	Dodecyl trichlorosilane
Boron trifluoride	Ethyl trichlorosilane
Bromine monofluoride	Fluorine monoxide
Bromine pentafluoride	Fluorosulfonic acid
Bromine trifluoride	Gold acetylide
Bromodiethyl aluminum	Hexadecyl trichlorosilane

Hexyl trichlorosilane	Potassium hydride
Hydrobromic acid	Potassium oxide
Iodine monochloride	Potassium peroxide
Lithium	Propyl trichlorosilane
Lithium aluminum hydride	Pyrosulfuryl chloride
Lithium amide	Silicon tetrachloride
Lithium ferrosilicon	Silver acetylide
Lithium hydride	Sodium hydride
Lithium peroxide	Sodium methylate
Lithium silicon	Sodium peroxide
Magnesium peroxide	Sodium potassium alloy
Methyl aluminum sesquibromide	Stannic chloride
Methyl aluminum sesquichloride	Sulfonyl fluoride
Methyl dichlorosilane	Sulfuric acid (>70%)
Methylene diisocyanate	Sulfur chloride
Methyl isocyanate	Sulfur pentafluoride
Methyl trichlorosilane	Sulfur trioxide
Methyl magnesium bromide	Sulfuryl chloride
Methyl magnesium chloride	Thiocarbonyl chloride
Methyl magnesium iodide	Thionyl chloride
Nickel antimonide	Thiophosphoryl chloride
Nonyl tichlorosilane	Titanium tetrachloride
Octyl trichlorosilane	Toluene diisocyanate
Phenyl trichlorosilane	Triethyl aluminum
Phosphonium iodide	Triisobutyl aluminum
Phosphorous pentoxide	Trimethyl aluminum
Phosphorous oxychloride	Trichlorosilane
Phosphorous pentasulfide	Tri-n-butyl aluminum
Phosphorous trisulfide	Trichloroborane
Phosphorous (red)	Triethyl arsine

Phosphorous oxybromide	Triethyl stibine
Phosphorous pentachloride	Tri-n-butyl borane
Phosphorous sesquisulfide	Tripropyl stibine
Phosphorous tribromide	Trioctyl aluminum
Phosphorous trichloride	Trisilyl arsine
Polyphenyl polymethyl isouantate	Trivinyl stibine
Potassium	Vanadium trichloride
	Vinyl trichlorosilane
	Zinc acetylide

Partial List of Acutely Toxic Chemicals

Acrolein	Nitrogen tetroxide
Acrylyl chloride	Nitrogen trioxide
2-Aminopyridine	Organo Tin compounds
Benzyl chloride	Osmium tetroxide
Bromine	Oxygen difluoride
Chlorine dioxide	Ozone
Chlorine trifluoride	Pentaborane
Chlorpicrin	Perchloromethyl mercaptan
Cyanogen chloride	Phosphorus oxychloride
Cyanuric fluoride	Phosphous trichloride
Decaborane	Sarin
Dichloro acetylene	Sulfur monochloride
Dimethyl disulfide	Sulfur pentafluoride
Dimethylsulfate	Sulfuryl chloride
Dimethylsulfide	Tellurium hexafluoride
Ethylene chlorohydrin	Tetramethyl succinonitrile
Ethylene fluorohydrin	Tetranitromethane
Hexamethylene diisocyanate	Thionyl chloride
Hexamethyl phosphoramide	Toluene-2,4-diisocyanate
Iodine	Trichloro (chlormethyl) silane
Iron pentacarbonyl	
Isopropyl formate	
Methacryloyl chloride	
Methacryloxyethyl isocyanate	
Methyl acrylonitrile	
Methyl chloroformate	
Methylene biphenyl isocyanate	
Methyl fluoroacetate	
Methyl fluorosulfate	
Methyl hydrazine	
Methyltrichlorosilane	
Methyl vinyl ketone	

Partial List of Acutely Toxic Gases

This list is provided as a guide and is not all-inclusive. Carefully review material Safety data sheets before working with chemicals.

Name	**CAS#**
Arsenic pentafluoride	7784-36-3
Arsine	7784-42-1
Boron trifluoride	7637-07-2
Chlorine	7782-50-5
Chloropicrin in gas mixtures	76-06-2
Cyanogen bromide	506-68-3
Cyanogen chloride	506-77-4
Cyanogen	460-19-5
Diazomethane	334-88-3
Diborane	19287-45-7
Fluorine	7681-49-4
Germane	7782-65-2
Hexaethyl tetraphosphate (Tetraphosphoric acid, hexaethyl ester)	757-58-4
Hydrogen cyanide	74-90-8
Hydrogen selenide	7783-07-5
Methyl mercaptan	74-93-1
Nitric oxide	10102-43-9
Nitrogen dioxide	10102-44-0
Nitrogen Tetroxide	10544-72-6
Oxygen difluoride	7783-41-7
Phosgene	75-45-5
Phosphine	1498-40-4
Phosphorus pentafluoride	7641-19-0
Selenium hexafluoride	7783-79-1
Silicon tetrafluoride	7783-61-1
Stibine	10025-91-9
Sulfur tetrafluoride	7783-60-0

Hazards of Mercury

Mercury exists in three forms: elemental mercury, inorganic mercury compounds (primarily mercuric chloride), and organic mercury (primarily methyl mercury). All forms of mercury are quite toxic, and each form exhibits different health effects. Mercury moves between the water, air, and soil as a result of human and natural activities. In this country alone, 870 pounds of mercury is added to the atmosphere each day from human sources. Organic mercury, including methyl mercury, are more toxic than elemental mercury or inorganic mercury compounds.

Methyl Mercury bio-accumulates in fish and becomes more concentrated as it moves up the food chain to humans and other animals. An adult walleye can have a mercury concentration 150,000 times higher as the water surrounding it(1). Mercury is the most frequent reason for fish consumption advisories in the U.S., accounting for 60% of all advisories in fresh water bodies. To date, 40 states have issued advisories for mercury in one or more bodies of water, and 11 states have issued them on a statewide basis.

Acute (short-term) exposure to high levels of elemental mercury and methyl mercury in humans results in central nervous system (CNS) effects such as hallucinations, delirium, blindness, deafness, and impaired level of consciousness. Effects on the gastrointestinal tract and respiratory system have also been noted in humans from acute inhalation exposure to elemental mercury.

Chronic (long-term) exposure to elemental mercury and methyl mercury in humans also affects the central nervous system. Effects such as erethism (increased excitability), irritability, excessive shyness, and a tremor have been noted from elemental mercury exposure, and symptoms such as paresthesia (a sensation of pricking on the skin), blurred vision, malaise, speech difficulties, and constriction of the visual field from methyl mercury exposure. The major effect from chronic exposure to inorganic mercury is kidney damage.

Methyl mercury exposure, via the oral route, exhibits significant developmental effects. Infants born to women who ingested high levels of methyl mercury exhibited mental retardation, ataxia, constriction of the visual field, blindness, and cerebral palsy.

If possible, lab personnel should find an alternative to mercury.

References:

www.epa.gov/grtlakes/p2/mercpam.html

https://www.epa.gov/mercury

Partial List of Select Carcinogens

Websites with information on select carcinogens and lists:

http://www.osha.gov/SLTC/carcinogens/index.html

http://www.epa.gov/ttn/atw/toxsource/carcinogens.html

http://www.cdc.gov/niosh/topics/cancer/npotocca.html

http://www.cancer.org/Cancer/CancerCauses/OtherCarcinogens/GeneralInformationaboutCarcinogens/known-and-probable-human-carcinogens

http://en.wikipedia.org/wiki/Carcinogen

CAS #	Chemical Name
76180966	(2-Amino-3-Methylimidazo[4,5-F]Quinoline)
57147	1,1-Dimethylhydrazine
96128	1,2-Dibromo-3-Chloropropane
106934	1,2-Dibromoethane
107062	1,2-Dichloroethane
1615801	1,2-Diethylhydrazine
540738	1,2-Dimethylhydrazine
106990	1,3-Butadiene
542756	1,3-Dichloropropene (technical grade)
1120714	1,3-Propane sultone
55981	1,4-Butanediol dimethylsulphonate
106467	1,4-Dichlorobenzene
123911	1,4-Dioxane
13909096	1-(2-Chloroethyl)-3-(4-Methylcyclohexyl)-1-Nitrosourea
13010474	1-(2-Chloroethyl)-3-Cyclohexyl-1-Nitrosourea
82280	1-Amino-2-Methylanthraquinone
555840	1-[5-Nitrofurfurylidene)Amino]-2-Imidazolidinone
1746016	2,3,7,8-Tetrachlorodibenzo-para-dioxin
52573	2,4,4'-Trinitroisoidiota
88062	2,4,6-Trichlorophenol
615054	2,4-Diaminoanisole
39156417	2,4-Diaminoanisole sulfate
95807	2,4-Diaminotoluene
3570750	2-(2-Formylhydrazine)-4-(5-Nitro-2-Furyl)Thizole gul P-
53963	2-Acetylaminofluorene
59716879	2-Amino-5-(5-Nitro-2-Furfuryl)-1,3,4-Thiadiazole (note T5)
712685	2-Amino-5-(5-Nitro-2-Furyl)-1,3,4-Thiadiazole (note T6)
117793	2-Aminoanthraquinone
129157	2-Methyl-1-Nitroanthraquinone(uncertain purity)
75558	2-Methylaziridine
91598	2-Naphthylamine
79469	2-Nitropropane
28434868	3,3'-Dichloro-4,4'-Diaminodiphenyl ether

CAS #	Chemical Name
91941	3,3'-Dichlorobenzidine-3,3'-Dichlorobenzidine and 3,3'-Dichlorobenzidine dihydr
119904	3,3'-Dimethoxybenzidine
119937	3,3'-Dimethylbenzidene
60153493	3-(N-Nitrosomethylamino)Propionitrile
563473	3-Chloro-2-Methylpropene
101804	4,4'-Diaminodiphenyl ether
101144	4,4'-Methylene bis(2-Chloraniline)
838880	4,4'-Methylene bis(2-Methylaniline)
101611	4,4'-Methylene bis(N,N-Dimethyl)Benzenamine
101779	4,4'-Methylenedianiline-4,4'-Methylenedianiline and its dihydrochloride
139651	4,4'-Thiodiamiline
64091914	4-(N-Nitrosamethylamino) 1-(3-Pyridyl)-1-Butanone
92671	4-Aminobiphenyl
95830	4-Chloro-Ortho-Phenylenediamine
539173	4-Dimethylaminoazobenzene (note T3)
60117	4-Dimethylaminoazobenzene (note T6)
92933	4-Nitrobiphenyl
3031514	5-(Morpholinomethyl)-3-[(5- Nitrofurfurylidene) Amino]
484208	5-Methoxypsoralen
3697243	5-Methylchrysene
99592	5-Nitro-O-Anisidine
602879	5-Nitroacenapththene
194592	7-H-Dibenzo [C,G] Carbazole-8-Methoxypsoralen (Methoxsalen) plus UV radiation A-Alpha-C(2-Amino-9H-Pyrido [2,3-B] Indole
75070	Acetaldehyde
60355	Acetamide
79061	Acrylamide
107131	Acrylonitrile
23214928	Adriamycin
3688537	AF-2[2-(Furyl)-3-(5-Nitro-2-Furyl)Acrylamide]
1402682	AflatoxinsAlpha-Chlorinated Toluenes
134327	Alpha-Napthylamine Aluminum Productions
61825	Amitrole Analgesic mixtures containing Phenacetin Androgenic (anabolic) Steroid Armite
7440382	Arsenic
1332214	Asbestos
492808	Auramine
115026	Azaserine
446866	Azathioprine
154938	BCNU
56553	Benz [A] Anthracene
71432	Benzene
92875	Benzidine

CAS #	Chemical Name
50328	Benzo(A)Pyrene
205992	Benzo(B)Fluoranthene Benzo(F)Fluoranthene
205823	Benzo(J)Fluoranthene
207089	Benzo(K)Fluoranthene
98077	Benzotrichloride
1694093	Benzyl Violet 4B
7440417	Beryllium
3068880	Beta-Butyrolacetone
57578	Beta-Propiolacetone Betel Quid with Tobacco
25013165	BHA
542881	Bis (Chloromethyl) Ether
8052424	Bitumens, extracts of stream refined and air refined Bleomycins Boot and Shoe Manufacture and Repair Bracken Fern
569619	C.I. Basic Red 9 Monohydrochloride
7440439	Cadmium Cadmium Compounds Carbon Black Extracts
56235	Carbon Tetrachloride Carpentry and Joinery Carrageenan, Degraded
305033	Chlorambucil
56757	Chloramphenicol
494031	Chloraphazine
143500	Chlordecone
115286	Chlorendic Acid
63449398	Chlorinated Paraffin's (C12 60% Chlorine)
329646	Chloroazodimethylisomoron
67663	Chloroform
107302	Chloromethyl Methyl Ether (note T5) Chlorophenols Chlorophenoxy Herbicides
7440473	Chromium Compounds, Hexavalent
15663271	Cisplatin
6358538	Citrus Red No. 2 Coal Gasification
8007452	Coal Tar
65996932	Coal Tar Pitches Coke Oven Emissions
12126599	Conjugated Estrogens
8001589	Creosotes
135206	Cupferron
14901087	Cycasin
50180	Cyclophosphamide
4342034	Dacarbazine
20830813	Daunomycin
50293	DDT
117817	DI (2-Ethylhexyl) Phthalate
191300	Dibenzo(A,L)Pyrene
192654	Dibenzo[A,E]Pyrene
189640	Dibenzo[A,H]Pyrene
189559	Dibenzo[A,I]Pyrene (note T6)

CAS #	Chemical Name
226368	Dibenz[A,H]Acridine
53703	Dibenz[A,H]Anthracene
224420	Dibenz[A,J]Acridine
75092	Dichloromethane
1464535	Diepoxybutane
64675	Diethyl Sulphate
56531	Diethylstilboestrol
101906	Diglycidyl Resorcinol Ether
94586	Dihydrosafrole
77781	Dimethyl Sulphate
79447	Dimethylcarbamoyl Chloride
513371	Dimethylvinyl Chloride
1937377	Direct Black 38
2602462	Direct Blue 6
106898	Epichlorohydrin
12510428	Erionite Estrogens (not conjugated): Estradiol 17B
53167	Estrogens (not conjugated): Estrone Estrogens (not conjugated): Ethinylestradiol
72333	Estrogens (not conjugated): Mestranol
140885	Ethyl Acrylate
62500	Ethyl Methanesulphonate
75218	Ethylene Oxide
96457	Ethylene Thiourea
151564	Ethyleneimine
50000	Formaldehyde Furniture and Cabinet Making Glu-P-2 (2-Aminodipyrido [1,2-A:3',2'-D] Imidaze)
765344	Glycidaldehyde
126078	Griseofulvin
1317608	Hematite Mining, underground, with exposure to radon
118741	Hexachlorobenzene
319846	Hexachlorocyclohexanes
680319	Hexamethylphosphoramide
302012	Hydrazine and Hydrazine Sulfate
122667	Hydrazobenzene
193395	Indeno(1,2,3-CD)Pyrene Iron and Steel Founding
9004664	Iron-Dextran Complex
67630	Isopropyl Alcohol manufacture, strong acid process
303344	Lasiocarpine
301042	Lead Acetate
7439921	Lead and Lead Compounds, inorganic
7446277	Lead Phosphate
58899	Lindane and other Hexachlorocyclohexane
632995	Magenta Mea-Alpha-C (2-Amino-3-Methyl-9H-Pyrido [2,3-B] Indole)

CAS #	Chemical Name
71589	Medroxyprogestrone Acetate
148823	Melphalan
531760	Merchalan
298817	Methoxasalen with UV therapy
66273	Methyl Methanesulphonate Methylazoxymethanol and its acetate
56042	Methylthiouracil
443481	Metronidazole
90948	Michler's Ketone Mineral Oils, mildly treated ineral Oils, untreated
2385855	Mirex
315220	Monocrotaline Mopp and other combined therapy
505602	Mustard Gas (sulfur mustard)
50077	Mytomycin C
613354	N,N-'Diacetylbenzidine
759739	N-Ethyl-N-Nitrosourea
70257	N-Methyl-N'-Nitro-N-Nitrosoguanidine
614959	N-Methyl-N-Nitrosourethane
684935	N-Methyl-N-Nitrosurea
924163	N-Nitrosodi-N-Butylamine
621647	N-Nitrosodi-N-Propylmine
1116547	N-Nitrosodiethanolamine
55185	N-Nitrosodiethylamine
62759	N-Nitrosodimethylamine
13256138	N-Nitrosoethylvinylamine (note T4)
10595956	N-Nitrosomethylethylamine
4549400	N-Nitrosomethylvinylamine (note T6)
59892	N-Nitrosomorpholine
16543558	N-Nitrosonornicotine
100754	N-Nitrosopiperidine
930552	N-Nitrosopyrrolidine
13256229	N-Nitrososarcosine
531828	N-[4-(5-Nitro-2-Furyl)-2-Thiazolyl]Acetamide
3771195	Nafenopin
7440020	Nickel Nickel Compounds Nickel Refining
61574	Niridazole
139139	Nitrilotriacetic Acid
1836755	Nitrofen (technical grade)
51752	Nitrogen Mustard
55867	Nitrogen Mustard Hydrochloride
126852	Nitrogen Mustard N-Oxide
302705	Nitrogen Mustard N-Oxide Hydrochloride
68224	Norethisterone
134292	O-Anisidine Hydrochloride Oestrogen replacement therapy Oestrogen, non-steroidal Oestrogen, steroidal
2646175	Oil Orange SS Oral Contraceptives, combined Oral Contraceptives, sequential

CAS #	Chemical Name
97563	Ortho-Aminoazotoluene
90040	Ortho-Anisidine
95534	Ortho-Toluidine and O-Toluidine Hydrochloride
434071	Oxymetholone
156105	P-Nitrosodiphenylamine
794934	Panfuran S (containingdihydroxymethylfuratrizine)
60093	Para-Aminoazobenzene Para-Chloro-Ortho-Toluidine
120718	Para-Cresidine
127184	Perchloroethylene
62442	Phenacetin
136403	Phenazopyridine Hydrochloride
57307	Phenobarbital
63923	Phenoxybenzamine Hydrochloride
57410	Phenytoin
36355018	Polybrominated Biphenyls
1336363	Polychlorinated Biphenyls
8001352	Polychlorinated Camphenes
3564098	Ponceau 3R
3761533	Ponceau MX
7758012	Potassium Bromate
366701	Procarbazine Hydrochloride
57830	Progestins
75569	Propylene Oxide
51525	Propylthiouracil
50555	Reserpine Rubber Industry
81072	Saccharin
94597	Safrole
7446346	Selenium Sulfide
68308349	Shale-Oils
14464461	Silica, Crystalline
132274	Sodium Ortho-Phenylphenate Soots, Tars and Mineral Oils
10048132	Sterigmatocystin
18883664	Streptozotocin
100425	Styrene
96093	Styrene Oxide
95067	Sulfallate Talc containing Asbestiform Fibers
62555	Thioacetamide
52244	Thiotepa
62566	Thiourea
1314201	Thorium Dioxide Tobacco products, smokeless Tobacco Smoke
584849	Toluene Diisocyanates (note T4)
55738540	Trans-2-[(Dimethylamino)Methylimino]-5-[2-(5-Nitro-2-Furyl)
299752	Treosulphan
126727	Tris (2,3-Dibromopropyl) Phosphate
62450060	TRP-P-1 (3-Amino-1,4-Dimethyl-5H-Pyrido [4,3-B] Indole)

CAS #	Chemical Name
62450071	TRP-P-2 (3-Amino-1-Methyl-5H-Pyrido [4,3-B] Indole)
72571	Trypan Blue
66751	Uracil Mustard
51796	Urethane
593602	Vinyl Bromide
75014	Vinyl Chloride

74 Ways to Reduce Hazardous Waste in the Laboratory

1. Attend Hazardous Waste Generator Training.
2. Write your own waste management/reduction policy.
3. Include waste reduction as part of student/employee training.
4. Use manuals such as the American Chemical Society (ACS) "Less is Better" as part of your training.
5. Create an incentive program for waste reduction.
6. Centralize ordering of chemicals through one person in the lab.
7. Inventory chemicals at least once a year.
8. Indicate in the inventory where chemicals are located.
9. Update inventory when chemicals are purchased or used up.
10. Purchase chemicals in smallest quantities needed.
11. If trying out a new procedure, try to obtain the chemicals needed from another lab or purchase a small amount initially. After you know you will be using more of this chemical, purchase in larger quantities.
12. Date chemical containers when received so that older ones will be used first.
13. Audit your lab for waste generated: quantity, type, source, and frequency.
14. Keep SDSs for chemicals used on file.
15. Keep information about disposal procedures for chemical waste in your lab on file.
16. Store chemicals in storage area except when in use.
17. Establish an area for storing chemical waste.
18. Minimize the amount of waste kept in storage. Call the RMMC at ext. 3698 or 3697 to arrange for disposal as often as you need.
19. Label all chemical containers as to their content.
20. Develop procedures to prevent and/or contain chemicals spills - purchase spill clean-up kits, contain areas where spills are likely.
21. Keep halogenated solvents separate from non-halogenated solvents.
22. Keep recyclable waste/excess chemicals separate from non-recyclables.
23. Keep organic wastes separate from metal-containing or inorganic wastes.
24. Keep non-hazardous chemical wastes separate from hazardous waste.
25. Keep highly toxic wastes (cyanides, etc) separated from above.
26. Avoid experiments that produce wastes that contain both radioactive and hazardous chemical waste.
27. Keep chemical wastes separate from normal trash (paper, wood, etc).

28. Use the least hazardous cleaning method for glassware. Use detergents such as Alconox, Micro, RBS-35 on dirty equipment before using KOH/ethanol bath, acid bath, or No Chromix.
29. Eliminate the use of chromic acid altogether.
30. Eliminate the use of uranium and thorium compounds (naturally radioactive).
31. Substitute red liquid (alcohol) thermometers (range up to 150^{o}C) for mercury thermometers where possible.
32. Use a metal oven thermometer instead of mercury thermometer in ovens.
33. Use a digital thermometer where possible.
34. Evaluate laboratory procedures to see if less hazardous or non-hazardous reagents could be used.
35. Review the use of highly toxic, reactive, carcinogenic or mutagenic materials to determine if safer alternatives are feasible.
36. Avoid the use of reagents containing: barium, arsenic, cadmium, chromium, lead, mercury, selenium, and silver.
37. Consider the quantity and type of waste produced when purchasing new equipment.
38. Purchase equipment that enables the use of procedures that produce less waste.
39. Review your procedures regularly (e.g. annually) to see if quantities of chemicals and/or chemical waste could be reduced.
40. Look into the possibility of including detoxification and/or waste neutralization steps in laboratory experiments.
41. When preparing a new protocol, consider the kinds and amounts of waste products and see how they can be reduced or eliminated.
42. When researching a new or alternative procedure, include consideration of the amount of waste produced as a factor.
43. Examine your excess chemicals to determine if there are other personnel in your lab, neighboring labs, departments or areas (garage, paint shop) that might be able to use them.
44. Review the list of surplus chemicals or contact the RMMC (ext. 3698, 3697, or 3696) to see if chemicals needed are available before purchasing chemicals.
45. Consolidate film-developing activities in centralized location with other departments.
46. When solvent is used for cleaning purposes, use fresh solvent only for final cleaning.
47. Try using detergent and hot water for cleaning parts instead of solvents.
48. Consider purchasing a vacuum bake or bead blaster for cleaning of parts.
49. Reuse acid mixtures for electropolishing.
50. When cleaning substrates or other materials by dipping, process multiple items in one day.

51. Use smallest possible container for dipping or for holding photographic chemicals.

52. Use best geometry of substrate carriers to conserve chemicals.

53. Store and reuse developer in photo labs.

54. Precipitate silver out of photographic solutions for reclamation.

55. Neutralize corrosive wastes with other corrosive wastes that don't contain metals at the lab bench.

56. Evaluate the possibility of re-distillation of solvents in your lab.

57. Scale down experiments producing hazardous waste whenever possible.

58. In teaching labs, consider the use of micro-scale experiments.

59. In teaching laboratories that generate chemical wastes, use demonstrations or video presentations as a substitute for student experiments.

60. Use pre-weighed or pre-measured reagent packets for introductory teaching labs where waste is high. Use non-hazardous chemicals for weighing or measuring practice.

61. Include waste management as part of the pre- and post-laboratory written student experience.

62. Encourage orderly and tidy behavior in lab.

63. Polymerize epoxy waste to a safe solid.

64. Consider using solid phase extractions for organics.

65. Rota-vap: Organic solvents to be reused.

66. Run mini SDS-Page 2d gels instead of full-size slabs.

67. Seek alternatives to phenol extractions (e.g. small scale plasmid prep using no phenol may be found in Biotechnica, Vol. 9, No. 6, pp. 676-678).

68. Use procedures to collect metallic mercury.

69. Purchase compressed gas cylinders, including lecture bottles, only from manufacturers who will accept the empty cylinders back.

70. When testing experimental products for private companies, limit donations to the amount needed for research. Return excess material and waste to private company (it belongs to the private company).

71. Return excess pesticides to the distributor.

72. Be wary of donations from outside the University. Accept chemicals only if you will use them within 12 months.

73. Send us other suggestions for waste reduction (ext. 3698, 3697, 2638, 2723, or 2649).

74. Use alternate chemicals and substitute where possible:

Original Material	*Substitute*	*Comments*
Acetamide	Stearic acid	In phase change and freezing point depression
Benzene	Alcohol	
Benzoyl peroxide	Lauryl peroxide	When used as a polymer catalyst
Carbon tetrachloride	Cyclohexane	In test for halide ions
Chloroform	1,1,1-trichloroethane	
Fluorinert	Non-volatile, reusable pressurizing fluid	Carbon disulfide
Formaldehyde	"Formalternate"	Storage of biological specimens (Flinn Scientific)
Formaldehyde	Ethanol	For storage of biological specimens
Formalin	See Formaldehyde	
Halogenated solvents	Non-halogenated solvents	In parts washers or other solvent processes
Sodium dichromate	Sodium hypochlorite	
Sulfide ion	Hydroxide ion	In analysis of heavy metals
Toluene	Simple alcohols and ketones	
Wood's metal	Onion's Fusible alloy	
Xylene	Simple alcohols and ketones	
Xylene or toluene based liquid scintillation cocktails	Non-hazardous proprietary liquid scintillation cocktails	In radioactive tracer studies

Laboratory Safety Rules

To promote Safety for you and your fellow personnel while working in the laboratory,

Please observe the following rules.

- Never work in the laboratory alone.
- Do not perform unauthorized experiments.
- Do not take any equipment, substances, or specimens out of the laboratory.
- Use good housekeeping practices.
- Use the biohazard kits provided when dealing with accidents that result in exposure to human blood. Dispose of bandages and/or clean up materials in the red biohazard bags.
- Use of human blood in experiments is forbidden.
- Wash hands & arms with soap and water before leaving work area -- even if gloves were worn.
- Always use eye protection and use other personal protective devices as needed.
- No smoking, use of food/gum/drinks, or horseplay is permitted in the laboratory.
- Do not eat or drink from any laboratory glassware.
- Do not use mouth suction for any reason.
- Use a fume hood when working with substances that produce strong odors or fumes.
- Ground all electrical equipment before using, and proceed with caution.
- Never use a piece of cracked or broken glassware. Dispose of clean broken glass in the disposal box.
- Dispose of all waste substances properly. Consult the lab supervisor and SDS file for instructions.
- Note the location of all Safety features in the laboratory: fume/exhaust hoods, eye wash station, Safety shower, fire extinguisher, fire blanket, water wands, wash-up sink, and SDS files.
- Learn the hazards and physical properties of the materials used in the laboratory from labels and SDS's (e.g., corrosive, flammable, reactive, toxic).
- Headset-style music sources are not permitted in the laboratory.

REPORT ALL ACCIDENTS OR INJURIES: TO YOUR LAB SUPERVISOR IMMEDIATELY.

In the event of cuts, burns, or inhalation of fumes,
Your Supervisor will arrange for treatment and transportation as needed.

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In the event of cuts, burns, or inhalation of fumes,
Your Supervisor will arrange for treatment and transportation as needed.

EYE PROTECTION - All personnel working or visiting laboratories are required to wear approved Safety goggles or eye protection. If possible, prescription glasses should be worn while doing lab work replacing contact lenses. If chemicals come in contact with the eyes, wash with flowing water for 15-25 minutes and seek immediate medical attention.

APPROPRIATE CLOTHING - Long hair must be securely confined. Personnel must wear low heeled, closed toe shoes, long pants or knee-length skirt, shirt with sleeves (either long or short), or a knee-length lab coat/lab apron over appropriate clothing. Gloves should be worn when handling hazardous chemicals, sharp or hot objects.

***NOTE*: Consult a physician if you are pregnant, plan to become pregnant, or have any other medical condition, which might render you susceptible to exposure to the chemicals used in this laboratory.**

I have read and understand the above Laboratory Safety Rules and will cooperate fully.

Name: (Please print legibly)

_____

Date: _____ **Course:** _____ **Lab Location:** _____

Signature:

_____

XI. Laboratory Safety Self-Survey Form

The following form is to be utilized regularly by Principal Investigators and other laboratory staff. Upon request by the Chemical Safety Specialist, (at least annually) PI's are to complete the survey form and submit competed document to UW Safety. Hill Hall. Please contact the University Chemical Safety Specialist at 6-3277 with any questions.

Principal Investigator: _____

Department: _____

Building: _____ Room Number: _____

Person completing form: _____ Phone Number: _____

Date: _____

Y = Satisfactory Condition N = Needs Improvement N/A = Not Applicable

HAZARDOUS MATERIALS:

1. Labeling and Signage:

a. Original product names **(full chemical names, no abbreviations)** and hazards are clearly identified on labels ____

b. All secondary containers of hazardous and non-hazardous substances are labeled explicitly to avoid confusion **(Full chemical name, no abbreviations).** ____

c. Emergency contact information Sign: Office Phone, After Hours Phone ____

d. Notice sign: No Food, No Drink, No Smoking and Eye Protection Required ____

e. Notice Sign: Safety Data Sheets and Spill Kits located ____

2. Control:

a. Designated sign area established for the use of regulated carcinogens ____

b. Incompatible chemicals are segregated. ____

c. Containers of peroxide-forming chemicals are dated upon receipt and tested for peroxides upon opening every 6 months ____

Y = Satisfactory Condition N = Needs Improvement N/A = Not Applicable

d. Flammable liquids are stored away from sources of ignition ____

e. All chemical containers are capped and sealed, except when Adding or removing materials from. ____

f. No intentional disposal of chemicals by evaporation in fume hood ____

g. Chemicals stocks are rotated ____

3. Storage of Flammable/Combustible Liquids: (NFPA Guidelines)

a. Flammable liquid storage cabinet(s) used and adequate for needs. 25 gal maximum of total solvents ____

b. Flammable liquids are not stored outside of storage cabinets in Excess of 10 gallons: unless secondary containment is provided for containers over 5 gal ____

HAZARDOUS WASTE:

1. Containment and Storage:

a. Waste is contained according to UW guidelines ____

b. Waste containers are sturdy, plastic coated, routinely inspected for leaks Compatible with the waste and kept closed when waste is not being added or removed ____

c. Stored for not more than 90 days from initial date of addition ____

d. Waste pick-up forms are available online. ____

e. All waste must have secondary containment. ____

2. Labeling of Waste Containers:
Containers are labeled with the initial date of accumulation, with the words "Hazardous Waste", and with full names and percentages **(Full chemical names, no abbreviations)** ____

HEALTH AND SAFETY EQUIPMENT:

1. Eyewashes and Safety Showers:

a. Eyewashes are provided within the work area for immediate use and/or access to them is not obstructed. ____

b. Eyewash units are to be inspected weekly for proper functioning and tag initialed by the principal investigator (PI) or assigned staff/student ____

c. Safety Showers are provided within the work area for immediate use and/or access to them is not obstructed ____

Y = Satisfactory Condition N = Needs Improvement N/A = Not Applicable

d. Safety Showers units are to be inspected quarterly for proper functioning and tag initialed by the UW SAFETY personnel ____

2. Laboratory Fume Hoods:

a. Fume Hoods are to be inspected yearly for proper functioning at 100 ft/min flow and tag initialed by the UW SAFETY personnel ____

b. Air flow indicator is present ____

c. Storage within hood is minimized and containers are kept sealed ____

d. Front sash is lowered to appropriate level when hood is used. ____

3. Compressed Gas Cylinder Safety:

a. Cylinders are protected from external heat sources in dry locations away from highly combustible materials ____

b. Secured to a structural component of the building ____

c. Protective caps are in place while cylinder is not in use or connected for use ____

4. Housekeeping and Miscellaneous Laboratory Safety:

a. Bench tops clean and uncluttered; environments maintained to eliminate harmful exposures or unsafe conditions ____

b. Ignition sources are kept out of fume hoods ____

c. Equipment electrical cords are not to be frayed or taped up ____

d. Extension cords are to be used as temporary service only ____

e. No daisy chaining of power strips and extension cords. ____

f. Safety glasses, goggles or face shields available ____

g. Lab coats and aprons available ____

h. Appropriate gloves available ____

i. First Aid Kits and supplies are available in labs. ____

PERSONAL HEALTH AND SAFETY:

1. Training:

a. Safety training documentation is complete and current. ____

b. Supervisor/PI has a specialized written training plan for lab ____

Y = Satisfactory Condition N = Needs Improvement N/A = Not Applicable

2. Food and Drink:

a. Stored and consumed where they may not be contaminated by toxic chemicals ____

b. Edibles not stored in refrigerator or freezer unless dedicated for food and is labeled such ____

c Refrigerators/freezers/microwaves clearly signed for the type of material stored in them and with the words: ____

"CHEMICALS AND SAMPLES ONLY NO FOOD OR DRINK ITEMS"

"MICROWAVE – CHEMICLAS AND SAMPLES ONLY"

"FOOD AND DRINK ITEMS ONLY NO CHEMICALS OR SAMPLES"

"MICROWAVE – FOOD ITEMS ONLY"

EMERGENCY PREPAREDNESS:

1. Emergency Procedures:

a. Chemical spill/cleanup materials provided ____

b. Training in spill cleanup procedures provided and documented ____

2. Fire Prevention:

a. Appropriate fire extinguisher available within 75 feet and Inspected within last year **(see tag)** ____

b. Access to fire extinguisher is unobstructed ____

3. Exits:

a. Exits and aisles are clear and free of potential obstructions ____

b. Exit signs are readily visible ____

LABORATORY EQUIPMENT:

1 Moving mechanical parts and vacuum pump belts are adequately protected by a guard ____

2. Equipment supports are strong, stable and un-corroded ____

3. Equipment wiring, cords and switches are not frayed, disconnected or in poor condition ____

4. Equipment is grounded ____

5. Glassware is not cracked or splintered ____

XII. Fume Hood Policy

I. Introduction and Purpose

Fume hoods are generally considered to be the primary means of protection from inhalation of hazardous chemicals in laboratories. Thus, it is important to ensure that fume hoods are operating properly. This policy is intended for users of fume hoods, and to outline an evaluation program, guidelines for use, training, and a maintenance policy and specify responsibilities.

II. Definition of Fume Hood

According to the National Fire Protection Association, a laboratory hood, or fume hood, is defined as a "ventilated enclosure designed to capture, contain, and exhaust fumes, gases, vapors, mists, and particulate matter generated within the hood interior." A laboratory fume hood should **NOT** be confused with a biological Safety cabinet; this policy does not cover biological Safety cabinets.

III. Evaluation Program

A. Fume hoods will be surveyed annually by UW Safety to ensure that they are functioning properly. The survey will consist of the following:

1. Visual inspection of the physical condition of the hood interior, sash, and visible ductwork. If problems are noted that could affect the performance of the hood **(such as a cracked sash)**, they will be reported to Preventative Maintenance (PM) and the Physical Plant for repair. If there is a problem related to the users **(such as a cluttered hood)**, the problem will be reported to the Principal Investigator (PI). The PI is responsible to work with the laboratory user and the Chemical Safety Specialist to work with the user to remedy the problem.
2. Face velocity will be measured at 16 points in a grid pattern with the sash fully open. The average face velocity should be between 60 and 100 feet per minute (fpm), unless the fume hood is labeled as an Extreme Device. There should be less than +/- 20% variation in point-to-point velocity. If the average face velocity falls outside this range, or the point-to-point velocity shows greater variation, a determination will be made if the variance is due to placement of equipment in the fume hood. If it is not related to the equipment, the hood will be reported to PM for inspection and

maintenance work. Depending on the severity of the condition, UW Safety may tag the hood with a **"OUT OF SERVICE"** tag. If a hood is tagged, use of the hood shall be suspended until maintenance work has solved the problem. The face velocity will also be measured at various points in a grid pattern with the sash at various lowered heights. If the average face velocity is less than 100 fpm, the sash height that does produce a 100 fpm average will be found and the hood will be so labeled. The label will indicate with a line the safe maximum operating sash height. The sash will not be lowered below a reasonable working height (usually 12 inches) for this designation.

3. A smoke test will be performed to verify the hood's containment effectiveness. The hood face is traversed with smoke to observe the air flow patterns. If turbulence exists that causes back-flow or spill-over, the researcher will be asked to move equipment in the hood until an arrangement is found that will not cause that type of turbulence. If an arrangement cannot be found, the hood will be labeled with a **"OUT OF SERVICE"** tag. The hood will be reported to PM for and maintenance work by UW Safety.

B. All hoods will be labeled after the survey. The label will include the unique hood ID#, user restrictions (e.g. lines for sash height), inspector's name, date, telephone number for reporting fume hood problems, or a **"OUT OF SERVICE"** tag.

C. All hoods will be equipped with a flow indicator. New hoods, or hoods experiencing major repair, will be equipped with an electronic low-flow monitor. All other existing hoods will have a ribbon attached to the bottom of the sash. The ribbon will indicate if airflow is moving through the sash opening; if the user observes that the ribbon is not moving, work shall cease and the user shall call UW Safety to report it, **766-3277**.

IV. Guidelines for Use

When using a fume hood, one must remember that the hood does not provide absolute protection from the materials being used. Certain work practices are necessary in order for the hood to perform capably. The following practices: are recommended by the American Conference of Governmental Industrial Hygienists:

A. Conduct all operations, which may generate air contaminants at or above the appropriate Threshold Limit Value inside a hood.

B. Keep all apparatus at least 6 inches back from the face of the hood. A stripe on the bench surface is a good reminder.

C. Do not put your head in the hood when contaminants are being generated.

D. Do not use the hood as a waste disposal mechanism.

E. Do not store chemicals or apparatus in the hood.

F. Keep the hood sash closed as much as possible.

G. Keep the slots in the hood baffle free of obstruction by apparatus or containers.

H. Minimize foot traffic past the face of the hood.

I. Keep laboratory doors closed (exception: some laboratory designs require the lab doors to be open).

J. Do not remove hood sash or panels except when necessary for apparatus set-up; replace sash or panels before operating.

K. Do not place electrical receptacles or other spark sources inside the hood when flammable liquids, vapors or gases are present. No permanent electrical receptacles are permitted in the hood.

L. Use an appropriate barricade if there is a chance of explosion or eruption.

M. If the hood sash is supposed to be partially closed for operation, the hood should be so labeled and the appropriate closure point clearly indicated.

N. If a power failure occurs, all apparatus in hoods shall be turned off until it is verified that the hood is operational again.

O. Throw trash in the trash can; it can be sucked into the ductwork.

V. Training

A. Employees and students involved with the use of fume hoods shall be trained in the proper use of fume hoods, including an explanation of labels on hoods.

1. UW Safety will provide online fume hood training. All employees are required to attend at least once.

2. Departments, PI's and supervisors shall ensure that employees and students know the proper procedures for operating the specific fume hoods under their control.

B. Records of training will be kept by UW Safety.

VI. Maintenance

A. Preventive Maintenance, PM performs regular maintenance on fume hoods on the Laramie campus, detailed in their written policy.

B. Users have the responsibility to ensure that air is moving through the sash opening whenever they use the fume hood. Users should also check the physical condition of their hoods; if they notice any suspicious condition, call UW Safety, **766-3277**.

C. All requests for repairs or modifications to fume hoods are to be made to the Chemical Safety Specialist in UW Safety. Users are not allowed to repair or make modifications to fume hoods. UW Safety will turn in a work order to PM. PM will keep UW Safety informed of scheduling and completion of work. Departments are responsible for modification costs, and for HEPA and charcoal filter requests.

D. Notification is required for any work that takes the fume hood out of service for any period of time, and for any work that may result in direct exposure of personnel to the exhaust stream or the interior of the hood or duct. This protects both the users and maintenance workers from inadvertent exposure to airborne hazards. In addition, timely notification allows advance planning to minimize disruption of research and teaching.

E. If access into the fume hood is required by PM. PM will notify UW SAFETY who will then request the PI of the laboratory to have the fume hood emptied, cleaned and washed down, so there is no exposure to the PM staff.

Notification is the responsibility of UW Safety to both PM and the PI, the PI will notify the user. The

user is required to follow all requests of UW Safety and PM during the maintenance or repair procedure. This may include requests such as removing all chemicals, gas cylinders, radioactive or bio-hazardous materials from the hood. PM will notify UW Safety who will notify the PI of the laboratory and users when maintenance is complete and fume hoods may be used again.

VII. Perchloric Acid Hoods

A. Definition:

Perchloric acid hoods are specialty hoods designed for use with Perchloric acid above ambient temperatures. They are equipped with a wash-down system and a dedicated exhaust.

B. Requirements:

Because of the unique and dangerous properties of Perchloric acid, if it is to be used above ambient temperatures, it may only be used in a Perchloric acid hood. UW Safety may be called for the location of a Perchloric acid hood that may be used if one is not available.

Under no circumstances may Perchloric acid be used in a wooden or fiberglass hood!

Do not use a Perchloric acid hood for general purpose or radioactive use.

VIII. Responsibilities

A. Users:

1. Users are responsible for the proper use of standard fume hoods, walk-in fume hoods and glove boxes. Departments and PI's are responsible for training users in the proper use of the specific devices in their laboratory.
2. Users are responsible for ensuring that air is moving through the sash before using the hood, and that the sash is in the proper position.
3. Users are responsible for ordinary spill cleanup in fume hoods. Refer to the Spill Control Policy.
4. Users are responsible for reporting any problems or irregularities to the Chemical Safety Specialist in UW Safety.

B. UW Safety:

1. UW Safety is responsible for making annual surveys of the performance of fume hoods. They are also responsible for labeling of fume hoods and maintaining all records pertaining to fume hoods.
2. UW Safety is responsible for coordinating with PM for the repair, maintenance, and modifications of existing fume hoods; as well as installation of new fume hoods.

C. Preventive Maintenance (PM) and Physical Plant:

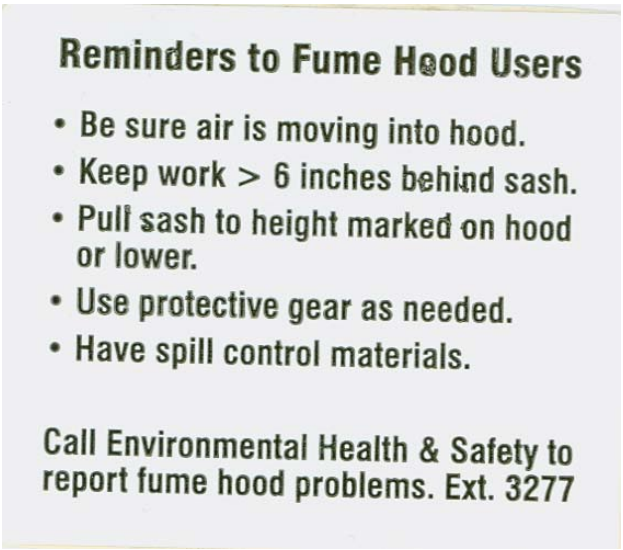
1. PM is responsible for performing a regularly scheduled maintenance program according to its written policy.
2. PM and Physical Plant is responsible for repair and modifications to existing fume hoods.
3. Physical Plant is responsible for design and installation of new fume hoods.

Reminders to Fume Hood Users

- · Be sure air is moving into hood
- · Keep work > 6 inches behind sash.
- · Pull sash to height marked on hood or lower.
- · Use protective gear as needed.
- · Have spill control materials.

Call UW Safety, 766-3277, to report fume hood problems.

Fume Hood Inspection Tags



Appendix 10

XIII. Laboratory Closeout Procedures, Checklist and Clearance Documents

The purpose of this procedure and checklist is to ensure the proper and safe disposition of all hazardous materials and equipment when a laboratory is vacated. The proper disposition of all hazardous materials used in laboratories is the responsibility of the principal investigator (PI) or researcher to whom the lab is assigned. The PI or investigator must ensure that all hazardous materials are moved, discarded, or transferred to another PI. **When the PI is unable to perform these duties, it becomes the responsibility of the Department Chair to ensure that these procedures are followed.** If management of hazardous materials at closeout requires removal, the Regulated Materials Management Center and UW Safety Office must be notified prior to the closeout. The disposal process may take some time and should be started **one month** before vacating the laboratory. Waste collection may take a week or more after notification that the waste is ready for pickup.

CONTACTS

UW Safety Office & Research Offices	
Chemical Safety Specialist:	**Biological Safety Specialist:**
766-2649	766-2723
Radiation Safety Officer:	**IH/Occupational Safety Specialist:**
766-2638	766-3203
Regulated Materials Management Center, RMMC	
Hazardous Materials Specialist:	**Hazardous Materials Supervisor:**
766-3697	766-3698

Checklist for Vacating Laboratories

Laboratory to be vacated	Building:	Room(s):
Principal Investigator:		**Department:**
Date laboratory will be vacated:		

When vacating a laboratory, the PI must either; move, discard or transfer responsibility for all potentially hazardous materials.

NOTE: Wear personal protective equipment appropriate for the materials being handled (safety glasses or goggles, lab coat, gloves, closed-toe shoes).

CHECKLIST:

Biological - Micro-organisms, Cultures, Recombinant Organisms:	**Done**	**N/A**
Cultures and solid, non-sharp biological waste autoclaved and placed in UW dumpster	☐	☐
Add bleach to liquid waste to final concentration of 10%, allow adequate contact time, then pour down drain	☐	☐
Disinfect benches and equipment used with cultures	☐	☐
Decontaminate and clean incubators, drying or curing ovens, refrigerators and freezers	☐	☐
If cultures are shipped to another facility, all shipping regulations must be followed	☐	☐
Cultures to be moved within campus must be transported in a primary and secondary container	☐	☐
See Waste Management for Disposal of materials		
Transfer responsibility to: _____		

Animal and Human Tissue:	**Done**	**N/A**
Separate tissues from preservative liquid; dispose of preservative as chemical waste	☐	☐
See Waste Management for Disposal of materials		
Transfer responsibility to: _____		

Radioactive Materials:	**Done**	**N/A**
Notify Radiation Safety Officer regarding lab closure/materials transfer	☐	☐
Package materials in approved and labeled waste containers	☐	☐
Perform contamination survey, decontaminate and re-survey if necessary	☐	☐
Arrange for a responsible person to be present during survey	☐	☐
Schedule Close-out survey with the Radiation Safety Officer	☐	☐
Remove all radiation signs, stickers, postings, etc.	☐	☐
Return all inventory documents to Radiation Safety Office	☐	☐
See Waste Management for Disposal of materials		
Transfer responsibility to: _____		

Chemicals	**Done**	**N/A**
Ensure all waste chemicals are in sealed, compatible containers	☐	☐
Identify all containers with full chemical name(s)	☐	☐
PI will, to the best of their ability, identify all unknowns: contact RMMC for guidance	☐	☐
Information concerning packaging chemically-contaminated materials: contact RMMC for guidance	☐	☐
Confirm that all chemicals have been removed from lab and support spaces	☐	☐
Clean all laboratory surfaces including hoods and storage cabinets	☐	☐
See Waste Management for Disposal of materials		
Transfer responsibility to: _____		

Gas Cylinders:	**Done**	**N/A**
If transferring usable gas cylinders to another lab, contact UW Safety for procedure	☐	☐
Return gas cylinders to supplier, if possible	☐	☐
If gas cylinders cannot be returned to supplier: contact RMMC	☐	☐
If unknown gases are present: contact UW Safety	☐	☐
See Waste Management for Disposal of materials		
Transfer responsibility to: _____		

Controlled Substances:	**Done**	**N/A**
Permission for transfer ownership of controlled substance received from DEA	☐	☐
Disposal of controlled substance has been arranged with the State Board of Pharmacy	☐	☐
Dept. Head has been notified of disposition of controlled substance	☐	☐
See Waste Management for Disposal of materials		
Transfer responsibility to: _____		

Waste Management – RMMC for all or any below:	**Done**	**N/A**
If autoclave not available, place in BioHaz bags and request pickup from RMMC	☐	☐
Place needles and syringes in sharps containers and request pickup from RMMC	☐	☐
Place human tissue in red BioHaz bag: contact RMMC for pick-up and disposal	☐	☐
Place animal carcasses/tissue in red BioHaz bag; contact RMMC for pick-up and disposal	☐	☐
Disposal of lead containers and shielding materials: contact RMMC	☐	☐
Submit_Radioactive Materials Request for Disposal Form via the internet: contact RMMC	☐	☐
Chemical and Hazardous Waste Removal Request Form submitted via the Internet: contact RMMC	☐	☐
Gas cylinders known and unknown: contact RMMC	☐	☐
Transfer responsibility to: _____		

Shared Storage Areas:	**Done**	**N/A**
Check all shared areas for hazardous materials	☐	☐
Mixed Hazards:	**Done**	**N/A**
If mixed hazards are identified, contact UW Safety / RMMC for guidance	☐	☐

Equipment and Lab Furniture:	**Done**	**N/A**
If laboratory equipment is to be discarded, be aware that capacitors, transformers, mercury switches, mercury thermometers, radioactive sources and chemicals must be removed before disposal. Contact UW Safety (766-3277) for assistance	☐	☐
Clean or decontaminate equipment or furniture to be left in lab, including fume hoods	☐	☐
Remove all chemical bottles (and debris) from fume hoods and process for disposal or transfer	☐	☐
Place contaminated bench top covers/liners from work surfaces in appropriately identified bags	☐	☐
Label non-working equipment with operational deficiency	☐	☐

Cleaning Procedures:	**Done**	**N/A**
• Clean laboratory bench tops and fume hood surfaces with soapy water.	☐	☐
• Decontaminate work surfaces using freshly prepared 10% bleach solution, 70% alcohol, or commercially available disinfecting solution.	☐	☐
• Decontaminate all biological safety cabinets using germicidal soap and rinse with de-ionized water. Do not use bleach on stainless steel surfaces.	☐	☐
• Decontaminate radioactive area work surfaces with commercially available decontamination product.	☐	☐

Department Clearance:

Principal Investigator's Agreement:	
I certify that my staff and I have adequately cleaned and decontaminated the laboratories under my supervision	
Principal Investigator's signature:	**Date:**
_____	_____
Department Chair:	
I am aware of the status of the lab(s) being vacated	
Departmental Chair/Unit Director Signature:	**Date:**
_____	_____

UW Safety & Research Offices Clearance:

Biological materials - lab has been cleared	
Signature:	**Date:**
_____	_____
Radioactive materials - lab has been cleared	
Signature:	**Date:**
_____	_____
Waste chemicals and materials - lab has been cleared	
Signature:	**Date:**
_____	_____
Chemical materials - lab has been cleared	
Signature:	**Date:**
_____	_____

XIV. Definitions

Action level means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Carcinogen (***see select carcinogen***).

Chemical Hygiene Officer means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

Chemical Hygiene Plan means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

Combustible liquid means any liquid having a flashpoint at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

Compressed gas means:

(i) A gas or mixture of gases having, in a container, an absolute pressure
(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or
(iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

Designated area means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

Emergency means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

Employee means an individual employed in a laboratory workplace that may be exposed to hazardous chemicals in the course of his or her assignments.

Explosive means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable means a chemical that falls into one of the following categories:

(i) ***Aerosol, flammable*** means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) ***Gas, flammable*** means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) ***Liquid, flammable*** means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) ***Solid, flammable*** means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).

(iv) Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous chemical means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

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

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

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

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

Medical consultation means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

Organic peroxide means an organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizer means a chemical other than a blasting agent or explosive as defined in § 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

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

Protective laboratory practices and equipment means those laboratory procedures, practices and equipment accepted by laboratory health and Safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Reproductive toxins means chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Select carcinogen means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.

Unstable (reactive) means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Water-reactive means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.