*Prudent Practices in the Laboratory NRC 1995* is used to cite policy references by state and federal agencies responsible for laboratory safety. Many of these general hygiene practices are typically unspecified in laws and regulations. Therefore, the following information has been provided to assist in the development of your Chemical Hygiene Plan. For the purposes of this plan employees and students are considered “laboratory workers.”

1. GENERAL HYGIENE PRACTICES

Ingestion

Laboratory workers must protect themselves from inadvertent ingestion of hazardous materials. Food and beverages are not permitted to be stored or consumed in any laboratory where there is a potential of contamination with chemical, radioactive, or biological hazardous materials. After handling hazardous materials, protective clothing and gloves should be removed, and any potentially contaminated body surface (such as hands) should be thoroughly washed prior to consumption of food or beverages. Application of cosmetics, such as hand lotion, etc., are also strongly discouraged in the laboratory.

* Glassware or utensils that have been used for laboratory operations must not be used to prepare or consume food or beverages.
* Laboratory refrigerators and cold or heated rooms must not be used for food or beverage storage.

Mouth Suction

Mouth suction must never be used to pipette chemicals or to start a siphon. Use a pipette bulb, aspirator bulb, or another source of vacuum for procedures requiring suction of materials.

Smoking

Smoking is prohibited in all campus laboratories. After handling hazardous materials, hands and face should be washed prior to smoking in an approved area.

Eye Protection

Laboratory Workers must be protected from hazardous materials. Eyes require protection from chemicals in all forms. In addition other potential hazards include impact of shattered glass or other projectiles, which may be generated during the handling of glassware or through grinding, burnishing or cutting procedures used in processing laboratory materials or other tasks.

* Goggles or face shields designed to protect the eyes and/or face from chemical splash shall be used whenever there is risk of splash or release of caustic or corrosive materials. Proper eye/face protection must also be used whenever a liquid containing toxic materials which can be absorbed through body surfaces is used (the eye is especially sensitive to absorption).
* Goggles, glasses or face shields designed to protect the eyes and/or face from impact from grinding, welding or potential failure of glassware and other anticipated projectiles shall be used whenever a risk of such damage is present in a laboratory.
* Contact lenses use must be evaluated in relation to the hazard and at a minimum chemical splash goggles worn in all circumstances to protect the eyes. The Laboratory supervisor and/or PI should be informed of contact lens use.

Dermal Exposure

Laboratory workers must protect themselves from dermal exposure to hazardous materials and from sharp utensils, glassware, and other mechanical or equipment hazards. At a minimum laboratory coats or aprons must be worn when handling hazardous materials. Laboratory coats must be buttoned to minimize chemical exposure to skin and/or clothing and to prevent snagging on laboratory equipment.

Foot Protection

Proper foot covering must always be worn in laboratories. Closed toed shoes are required to minimize potential exposure to hazardous materials. Appropriate specialized protective footwear such as steel toed shoes, rubber boots or shoe covers should be worn when certain hazards are present in the laboratory. Such hazards may include handling heavy items or powered equipment which can crush or pinch, wet floors or hazardous materials splashing/splattering.

Hand Protection

Gloves must be worn by laboratory workers when handling hazardous materials such as chemicals, potentially infectious materials and sharps. An appropriate glove/glove system must be chosen for each task.

Double-layering of gloves (one kind of glove worn over another) should be considered when highly hazardous materials are handled. Double-layering of gloves should also be considered when hazards associated with both chemical toxicity and sharp or abrasive equipment are present. The inner glove is designed to protect against chemical contact with the skin and the outer glove is a sturdy glove designed to resist puncture and abrasion.

The following guidelines apply to the selection and use of protective gloves:

h. Refer to the manufacturers guidelines in order to chose a glove made of a material known to be resistant to the substances in use. Wearing the wrong type of glove can be more hazardous than wearing no gloves at all, because if a chemical seeps through, the glove can hold it in prolonged contact with the wearer's hand.

i. Inspect gloves for small holes or tears before use.

ii. Wash gloves appropriately before removing them. (Note: some gloves, e.g., leather and polyvinyl alcohol, are water-permeable.)

iii. In order to prevent the unintentional spread of hazardous substances, remove gloves before handling objects such as doorknobs, telephones, pens, computer keyboards, etc.

iv. Replace gloves periodically, depending on the frequency of use and their permeation and degradation characteristics relative to the substances handled. (See Appendix F - for liks to various manufacturers Degradation Charts)

i. Jewelry and loose clothing

Jewelry may interfere with proper glove use and should not be worn with gloves. Necklaces, neckties, scarfs, bracelets, and other loose items may be damaged by chemicals, or may be caught in laboratory equipment, and therefore should not be worn in laboratories.

j. Hair

Long hair should be tied back or secured when working in a laboratory to reduce the risk of it becoming caught in laboratory equipment or being contaminated by chemicals.

2. CHEMICAL HAZARDS

Chemicals used in laboratories have a variety of hazards associated with them. Some chemicals present a high degree of toxicity, or present a danger to laboratory workers because they are explosive, highly flammable, or corrosive to tissue.

a. Reactive/Explosive

Unstable chemicals such as those classified as Class A Explosives (e.g., picric acid), highly reactive (e.g., strong reducing agents [sodium metal]) or oxidizing agents (e.g., perchloric acid), or chemicals which, over time, form explosive peroxides, must be inventoried. Class A Explosives are stabilized by the addition of water and become unstable when dehydration occurs. Dehydration or exposure to reducing agents may concentrate the material allowing it to become sensitive to heat and impact.

When new chemical stocks are received by the laboratory, they should be dated and periodically inspected at intervals no greater than 6 months to insure storage compatibility and the integrity of the chemical substance.

If during periodic inspection, any contamination of the chemical is noted, if it has become discolored or other physical characteristics have changed, do not move the material, and contact EHSD immediately at 335-3041.

b. Oxidizers

Mixing a strong oxidizing agents with moderate (flammable liquids) or strong (alkali metal or hydride) reducing agents can cause a fire or explosion.

Mixing a strong reducing agent with a moderate (water, air) or strong (oxo-compound) oxidizing agent may produce the same effect.

Therefore, these types of chemicals should never be stored together and chemical stocks should be inspected and inventoried at least annually to insure proper segregation.

Very strong (Class IV) oxidizers (e.g., 73% perchloric acid) are typically stabilized by water and may become unstable with age or with contamination by reducing agents. Class IV oxidizers which have become unstable may detonate without warning. If such chemicals are found to be discolored, or the physical characteristics have changed, do not move the material and contact EH&S immediately at 335-3041.

c. Peroxides

Chemicals which spontaneously form peroxides (with or without the presence of air) should be inspected at least every six months. Ethers (including dioxane and tetrahydrofuran) spontaneously form peroxides, even without the presence of air.

Exposure to air accelerates peroxide formation in ethers. Peroxide residues from oxidized ether are violently explosive.

In addition to ether, peroxides may form in olefins and in aromatic and saturated hydrocarbons, although generally more slowly than in ethers.

All chemicals in which peroxides form should be stored, handled, and utilized according to the manufacturer's instructions.

The expiration date should be clearly marked on the container prior to first opening.

Chemicals that form peroxides on aging should only be purchased in quantities that can be used within the shelf life, and not kept beyond that shelf life.

If you discover containers of ether or other peroxidizable chemicals to be more than one year old, do not move the material, and contact EH&S immediately at 527-5966.

d. Flammables

Highly flammable materials that are used in laboratory processes in volumes greater than one liter require certain additional safety practices. Many Flammable solvents also are toxic. Minimum training of laboratory workers should include what to do in case of fire, how to recognize toxic effects, and the emergency procedures for the chemicals used.

If large quantities of highly flammable materials are used, laboratory employees must never work alone with them.

In laboratories in which large quantities of highly flammable materials are used, appropriate fire suppression devices of sufficient number and quantity must be present. Consult with WSU Fire Services (335-1766) or the Environmental Health Services Department (335-3041) for information if questions arise.

e. Corrosives

Corrosive materials such as concentrated acids and bases can cause serious injury or death even in very small amounts. Additional hazards may be present for strong acids and salts containing fluorine. Organic compounds, like phenol, are not only highly toxic, but corrosive as well.

A thorough hazard analysis including PPE selection and certification is required for all chemicals to ensure that the appropriate PPE is worn. Employees must be fully trained prior to working with any laboratory chemicals.

f. Toxic Chemicals

Highly toxic chemical substances (such as cyanide, phenol, and compounds containing fluorine) must be recognized by all laboratory personnel who may come into contact with them. Specific emergency procedures for treatment of exposed laboratory workers and training in those procedures is required for all personnel.

3. CHEMICAL HAZARD LISTS

a. Acutely Hazardous Chemicals

Certain chemicals are regulated under hazardous waste rules at the time they are discarded. Washington Dangerous Waste Regulations (WAC 173-303) limit the amount of hazardous chemical waste which can be stored in the laboratory in which they are generated. The Washington Department of Ecology (DOE) places "dangerous wastes" into two categories; dangerous waste and acutely hazardous waste. Containers of dangerous waste can be stored in quantities up to 55 gallons. Acutely hazardous waste can only be stored in a quantity up to one quart before it must be removed, within three days, to a properly designed waste accumulation storage area or permitted facility. See S70.40 for a specific list of these chemicals.

b. Potentially Explosive Chemicals

Some chemical and reagent combinations have the potential for producing a violent explosion when subject to shock or friction. The following tables list some common laboratory reagents that can produce explosions when they are brought together or that generate reaction products which can explode without any apparent external initiating action.

4. INCOMPATIBLE CHEMICALS

In order to safely manage chemicals in a laboratory (or non-laboratory) setting, it is important to consider chemical reactions which may result from mixing together of chemical species. Mixing of chemicals may occur during a designed process, or it may occur inadvertently (e.g., mixing waste chemicals in a waste container, incompatible storage of chemicals). Three things should be considered in reference to chemical compatibility:

a. chemical Knowledge

Know the properties of the chemicals used. The chemical incompatibilities discussed below are by no means exhaustive. As a result, it is crucial for laboratory personnel to thoroughly research the properties of the chemicals used. Material Safety Data Sheets (MSDSs) all have sections on chemical incompatibility, and while the quality of MSDSs varies from one manufacturer to another; they should serve as a primary resource for information on avoiding contact with incompatible compounds. A more detailed reference is the Handbook of Reactive Chemical Hazards.

b. Waste Mixing

Avoid mixing incompatible waste materials. Use separate waste containers for each generated waste stream. Contact EH&S at 335-3041 for assistance with determining how to store waste.

c. Storage

Store incompatible chemicals separately. Storage of chemicals in alphabetical order on shelves often results in incompatible chemicals being stored together. For example, an alphabetical arrangement could result in hydrogen peroxide (a strong oxidizer) being stored next to a hydrazine (a strong reducer). If the shelf was jarred and these chemical containers broke together, a violent reaction may occur.

d. Chemical Classes

Storage of chemicals by class rather than alphabetically ensures that individual chemicals receive the proper storage measures warranted by their reactivity. Incompatibilities between classes can be anticipated and protected against. Alphabetizing within a group is then acceptable. An added benefit to this type of storage is that knowledge of chemical reactivity is transmitted to users of chemicals, who observe the proper storage practices.

i. Acids: Segregate acids from active metals such as sodium, potassium, magnesium, etc. Segregate oxidizing acids from organic acids, flammable solvents, and combustible materials. Some strong oxidizing acids, such as perchloric acid, should be stored separate from any other chemical and double containerized in compatible containers. Segregate acids from chemicals which could generate toxic or flammable gases upon contact, such as sodium cyanide, iron sulfide, calcium carbide, etc. Acids should be segregated from bases.

ii. Bases: Segregate bases from acids, metals, explosives, organic peroxides, and easily ignitable materials.

iii. Flammables: Store in approved safety cans or vented cabinets. Segregate from oxidizing acids and oxidizers. Keep away from any source of ignition: heat, sparks, or open flames.

iv. Oxidizers: Store in a cool, dry place. Keep away from combustible and flammable materials. Keep away from reducing agents such as zinc, alkali metals, and formic acid. Do not store oxidizers in or on wooden or metal shelves or cabinets (coating the shelf or cabinet surface with epoxy or other material which does not react with oxidizers is suggested). Some strong oxidizers will react violently on contact with other strong oxidizers. If this is the case, separate storage of these materials is advisable. Double-containerizing the individual containers to preclude inadvertent contact may be helpful.

v. Cyanides: Segregate from acids and oxidizers.

vi. Water Reactive Chemicals: Store in a cool, dry place away from any water source. Have a Class D fire extinguisher available in case of fire.

vii. Pyrophoric Substances: Store in a cool, dry place making provisions for an airtight seal.

viii. Light Sensitive Chemicals: Store in amber bottles in a cool, dry, dark place.

ix. Peroxidizable Chemicals: Store in airtight containers in a dark, cool, dry space. Label containers with receiving, opening, and disposal dates.

x. Toxic Chemicals: Store according to the nature of the chemical, using appropriate security where necessary.

e. Incompatible Storage Chart

The following chart lists some specific guidelines for the storage of hazardous chemical substances. These charts are not all inclusive and for any specific questions regarding chemical storage contact EH&S, 335-3041.

5. WASTE DISPOSAL

Chemical waste disposal laws are very complex and are inclusive of the majority of chemicals used in the laboratory. Improper storage and disposal of hazardous chemical wastes presents a direct liability to any person directly involved in storage and disposal. Supervisors and administrative officials share in that liability. See WSU Safety Policies and Procedures Manual, Section 70.40 for information about proper chemical waste management procedures.

In general, it is against the law to:

i. Dilute a hazardous chemical waste substance solely to reduce its concentration below regulated limits,

ii. Dump a hazardous chemical waste substance down a drain or into the environment,

iii. Dispose of a hazardous chemical waste in a waste basket, dumpster or landfill.

Consult with EH&S at 527-5966 regarding any questions about hazardous chemical waste disposal.

6. CHEMICAL SPILL MANAGEMENT

A chemical spill or uncontrolled release represents the single greatest potential for employee overexposure to a hazardous chemical. Employees expected to clean up spills of hazardous chemicals must be trained for the specific hazardous materials they will be cleaning up.

For clean-up of large spills contact EH&S at 527-5966 during normal working hours or 911 after normal working hours.

Contact EH&S at 527-5966 for further information regarding chemical spill clean-up.