Chemical Hygiene Plan

Revision 2022

TABLE OF CONTENTS

CONTACT INFORMATION

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Emergency Contacts

Department of Public Safety: 206-296-5911

Emergency Responders: 911 (dial 9-911 from a campus landline)

Poison Control: 800-222-1222

Mental Health Response: 988 (dial 9-988 from a campus landline)

INTRODUCTION

The Seattle University Chemical Hygiene Plan (CHP) aims to minimize exposures, injuries, illnesses and incidents associated with the use of hazardous chemicals in university laboratories by providing guidance on identifying and controlling chemical hazards and responding to emergencies. This written program is designed to meet the requirements of the Washington State Department of Labor & Industries (L&I) *Hazardous Chemicals in Laboratories*, Washington Administrative Code (WAC) 296-828.

The CHP complements the university's Accident Prevention Program and is implemented and applied in laboratories by the responsible faculty or area supervisor. Annual review and evaluation of the CHP is conducted by the Academic Safety Officer (ASO) in consultation with departments. Laboratory personnel are encouraged to provide feedback on the efficacy of the CHP to the ASO at any time.

Scope

Seattle University's CHP applies to Seattle University personnel who work in research and teaching laboratories that store, handle or use potentially hazardous chemicals. The CHP provides a broad overview of the information needed for safely working with hazardous chemicals in the laboratory; however, given the variety of chemical work performed in laboratories, this CHP is not intended to be all-inclusive.

This CHP does not cover the use of radiation (ionizing or non-ionizing), biological agents, shop equipment or other non-chemical hazards that may be found in laboratories. Procedures and requirements for work with these materials are covered by other programs.

HAZARD IDENTIFICATION

Chemical Hazard Classes

Chemicals may present health, physical and/or environmental hazards, and it is crucial for laboratory personnel to understand the hazards associated with the chemicals they work with and around. Classifying chemicals by hazard helps in determining the effects of a possible exposure; appropriate exposure response; and proper storage, handling and disposal procedures.

Faculty/supervisors are responsible for identifying hazardous materials, conditions or operations in laboratories in consultation with the ASO. Laboratory personnel should review the information in a material's safety data sheet (SDS) before working with the material. A single material may exhibit more than one hazard.

GHS Pictograms

The nine pictograms shown in **Table 1** are used under the United Nations' Globally Harmonized System (GHS) of Classification and Labelling of Chemicals to communicate hazards associated with chemicals. Pictograms are used on SDSs, chemical labels and other places where hazards are communicated.

Table 1: GHS Pictograms

Health Hazard	**Flame**	**Exclamation Mark**
 • Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	 • Flammable • Pyrophoric • Self-heating • Emits Flammable Gas • Self-reactive • Organic Peroxide	 • Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful) • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer[1]
Gas Cylinder	**Corrosion**	**Exploding Bomb**
 Gas under Pressure	 • Skin Corrosion/Burn • Eye Damage • Corrosive to Metals	 • Explosive • Self-reactive • Organic Peroxide
Flame over Circle	**Environment[1]**	**Skull and Crossbones**
 Oxidizer	 Aquatic Toxicity	 Acute Toxicity (fatal or severe)

[1]Non-mandatory

Health Hazards

Corrosive

Corrosive chemicals destroy or irreversibly damage other substances, including living tissue, by chemical reaction at the point of contact. Corrosive chemicals can be liquids, solids or gases and can affect the eyes, skin and/or respiratory tract. Common examples of corrosives include

- Strong acids and bases (e.g., hydrochloric acid, sulfuric acid, nitric acid, sodium hydroxide, potassium hydroxide),
- Certain weak acids or bases (e.g., phenol, acetic acid, ammonia),
- Oxidizing agents (e.g., chlorine, hydrogen peroxide) and
- Dehydrating agents (e.g., phosphorus pentoxide, calcium oxide).

Laboratory personnel handling corrosive chemicals should protect against contact or inhalation. Symptoms of inhalation exposure include coughing, burning sensation, wheezing, shortness of breath, nausea and vomiting. Symptoms of eye exposure include pain, bloodshot eyes, tearing and blurring of vision. Symptoms of skin exposure include reddening, pain, inflammation, bleeding, blistering and burns.

Irritant

Irritants reversibly damage living tissue by chemical reaction at the point of contact. Wide varieties of organic and inorganic chemicals—both solids and liquids—are irritants.

Laboratory personnel should exercise care to avoid contact with irritants. Symptoms of exposure include skin reddening, discomfort and respiratory system irritation.

Sensitizer

Chemical sensitizers can affect the respiratory system or skin, leading to hypersensitivity of the airways or allergic response, respectively, after repeated exposures. Common examples of sensitizers include latex, formaldehyde and peptide coupling agents.

Laboratory personnel handling sensitizers should avoid initial contact. Repeated exposure to sensitizers can lead to symptoms associated with allergic reactions ranging from runny nose or skin rash to anaphylaxis.

Particularly Hazardous Substance

Particularly hazardous substances are chemicals that pose a significant threat to human health and include select carcinogens, reproductive toxicants and substances with a high degree of acute toxicity. Additional provisions for working with particularly hazardous substances are described in *Controls*.

Select carcinogens are substances or mixtures of substances that induce cancer or increase its incidence. Their effects may present only after a long latency period, and there may be no immediate symptoms of exposure. Select carcinogens include any substance meeting at least one of the following criteria:

- Regulated by the Washington Industrial Safety and Health Act (WISHA) as a carcinogen (WAC 296-62-073)
- Listed as "known to be carcinogens" or "reasonably anticipated to be carcinogens" in the National Toxicity Program Annual Report on Carcinogens
- Listed in Group 1, 2A or 2B by the International Agency for Research on Cancer

Reproductive toxicants are chemicals that have adverse effects on reproductive ability in humans, including chromosomal damage (mutations) and developmental toxicity (embryolethality or teratogenesis). There may be no immediate symptoms of exposure to reproductive toxicants. Common examples of reproductive toxicants include ethidium bromide, formamide and toluene.

Acute toxicants are substances that may be fatal following a single exposure or multiple short exposures. Chemicals are identified as acute toxicants based on median lethal dose (LD_{50}) or median lethal concentration (LC_{50}) experiments in animal models. Toxicological information is available in section 11 of the material's SDS. Acute toxicants meet at least one of the following requirements:

- Oral LD_{50} ≤50 mg/kg in rats
- Dermal LD_{50} ≤200 mg/kg in rabbits
- Inhalation LC_{50} ≤500 ppm (gas), ≤2 mg/L (vapor) or ≤0.5 mg/L (mist, fume or dust) when administered continuously for 4 hours to rats

Examples of acute toxicants found in laboratories include sodium cyanide, sodium azide and hydrofluoric acid.

Toxic and Specific Target Organ Toxicity

Toxic chemicals can affect the liver (hepatotoxins), kidneys (nephrotoxins), nervous system (neurotoxins), blood (hematotoxins), lungs, skin, eyes or mucous membranes. Effects can be reversible or irreversible, can occur immediately or after a delay and can be caused by a single exposure or repeated exposures.

Symptoms of exposure to toxic chemicals vary. Laboratory personnel working with toxic chemicals should review exposure symptoms and protective measures in the SDS for each material before use.

Physical Hazards

Flammable

Flammable materials are generally identified based on flash point, the lowest temperature at which the material's vapors will ignite in air. Flammable liquids have flash points below 100 °F (38 °C). Information about whether a liquid, solid or gas is considered flammable can be found in its SDS.

Flammable chemicals should be handled in well-ventilated areas and away from ignition sources. Common examples of flammable materials include alcohols (e.g., ethanol, isopropanol), organic solvents (e.g., acetone, hexane, xylene), flash point solids (e.g., naphthalene), flammable gases (e.g., acetylene, hydrogen) and flammable metals (e.g., magnesium, titanium).

Pyrophoric

Pyrophoric materials spontaneously ignite when exposed to air. Pyrophoric chemicals are most commonly liquids but can also be solids or gases and require specialized handling techniques, additional engineering controls and extensive training to be safely handled. Examples of pyrophoric chemicals include *tert*-butyllithium, trimethylaluminum and silane.

Water Reactive

Water-reactive materials emit toxic or flammable gas when exposed to water and can be solids or liquids. The reaction with water often generates heat, leading to a fire. Some chemicals are so highly reactive with water that moisture in the air is sufficient to cause a violent reaction. Similar to pyrophorics, working with water reactives requires special handling techniques, engineering controls and training. Examples of water-reactive chemicals in the laboratory include alkali metals, trichlorosilane, sodium borohydride and methylmagnesium bromide.

Explosive and Potentially Explosive

Explosive chemicals are solids or liquids that are capable by themselves of chemical reaction that produces gas at such a temperature and pressure and at such speed that it damages the surroundings. An example of an explosive chemical is trinitrotoluene (TNT).

Though not inherently explosive, other chemicals are potentially explosive under certain conditions or following decomposition, polymerization, oxidation, drying out or another destabilizing event. An example of a chemical that becomes explosive when it dries out is picric acid.

Peroxide and Peroxide-forming

Organic peroxides are liquid or solid organic derivatives of hydrogen peroxide where one or both hydrogen atoms is replaced by an organic radical. Organic peroxides are thermally unstable and may undergo explosive decomposition or be impact- or friction-sensitive.

Peroxide-forming chemicals can form organic peroxides after exposure to air or light. To determine if a material is a peroxide-forming chemical, refer to its SDS. Examples of peroxide-forming chemicals are listed in Appendix B.

Oxidizer

Oxidizing chemicals initiate or promote combustion through a chemical reaction that can result in or intensify a fire or cause an explosion. Oxidizers can be liquids, solids or gases and should never be stored or unintentionally mixed with flammable or combustible materials. Common examples of oxidizers include pure oxygen, nitric acid and potassium permanganate.

Compressed Gas and Cryogenic

Compressed gas cylinders contain varying pressures of inert, toxic, flammable, oxidizing, corrosive or mixtures of gases or liquefied gases. Cryogenic liquids are refrigerated liquefied gases with boiling points below -130 °F (e.g., liquid nitrogen, liquid helium). Compressed gases and cryogens can create flammable or hazardous atmospheres; even inert gases undergo substantial volume expansion on release, which can lead to asphyxiation through oxygen depletion. Cryogens and dry ice can cause frostbite and can lead to rupture if placed in sealed containers.

Nanomaterials

Nanomaterials include substances or particles with at least one external dimension in the nanoscale (≤100 nm). Nanomaterials may present health and/or physical hazards that can differ from those associated with bulk materials. Although nanomaterials are increasingly used in research laboratories, their health effects have not been thoroughly investigated. Inhalation of nanomaterials has led to lung inflammation, fibrosis and cancer in animal models. Skin contact and ingestion may also lead to adverse effects. Certain nanoparticle dusts may present increased risk of fire or explosion. Laboratory personnel should exercise caution when working with nanomaterials and employ equipment and practices that prevent exposure.

Environmental Hazards

Materials with demonstrated toxicity to aquatic organisms are classified as toxic to the environment. These materials may also exhibit health or physical hazards. Environmental hazards should be stored, handled and disposed to minimize the risk of environmental release. Examples of environmental hazards include sodium azide, mercury, copper and organotin compounds.

Lab-developed Chemicals

Chemicals produced in the laboratory require special consideration. If the composition of the chemical substance is known and it is produced exclusively for the laboratory's own use, the faculty will determine whether it is hazardous. Chemical derivatives of known materials should be presumed to be at least as hazardous as their parent compound. If the chemical is produced as a byproduct of unknown composition, it shall be assumed to be hazardous.

Prior Approval

The materials below require special training, safety measures, registration, laboratory design and/or procedure approval before obtaining or beginning work with them. Contact the ASO for assistance.

Controlled Substances

The registration, procurement, inventory, storage, recordkeeping, use and disposal of controlled substances must comply fully with all applicable federal and state laws and regulations. Seattle University laboratories working with controlled substances must have active DEA registrations and specific approval for the controlled substance(s) on hand.

Select Agent Toxins

Select agents, including nine biological toxins, are regulated by the Centers for Disease Control and Prevention (CDC) and United States Department of Agriculture (USDA) because they have the potential to pose a severe threat to public, animal or plant health or to animal or plant products. Select agent toxins have specific handling, storage, inventory and security requirements and may need to be registered with the federal government.

Listed Carcinogens

Thirteen carcinogens, known as "listed carcinogens," are regulated by the federal and state government because they are considered to pose the highest cancer hazard. Use, handling or storage of listed carcinogens requires elevated laboratory design, containment equipment, personal protective equipment, training and medical surveillance.

Pyrophoric or Explosive Materials

The Seattle Fire Code requires specific firefighting measures and laboratory design elements in areas where pyrophoric or explosive materials are stored and handled.

Radionuclides

The use of unsealed radioactive materials requires a license from the Washington State Department of Health. Seattle University is not a permitted entity at the time of this writing.

CONTROLS

Controls are implemented to reduce risk to an acceptable level. The highest possible level of protection is elimination of hazards from the laboratory (**Figure 1**), which is not practical for many research and teaching purposes. Substitution of hazards with less hazardous alternatives (e.g., using toluene instead of benzene, cleaning with water-based detergents instead of solvents, scaling down) reduces the consequences of an exposure and should be employed when possible.

Engineering controls, administrative controls and personal protective equipment (PPE) can reduce the probability of chemical exposure. The controls employed are ultimately based on a risk assessment of the work being done, and the specifics may vary from laboratory to laboratory. All controls have points of failure, so redundant protection methods should be employed when feasible.

Consistent adherence to safe laboratory practices and appropriate use of controls are expected to keep chemical exposures to a safe level. Exposure risk is more likely to increase when handling hazardous chemicals without proper controls in place (e.g., working with an inhalation hazard outside of a fume hood). Laboratory personnel with concerns about chemical exposure should contact the ASO.

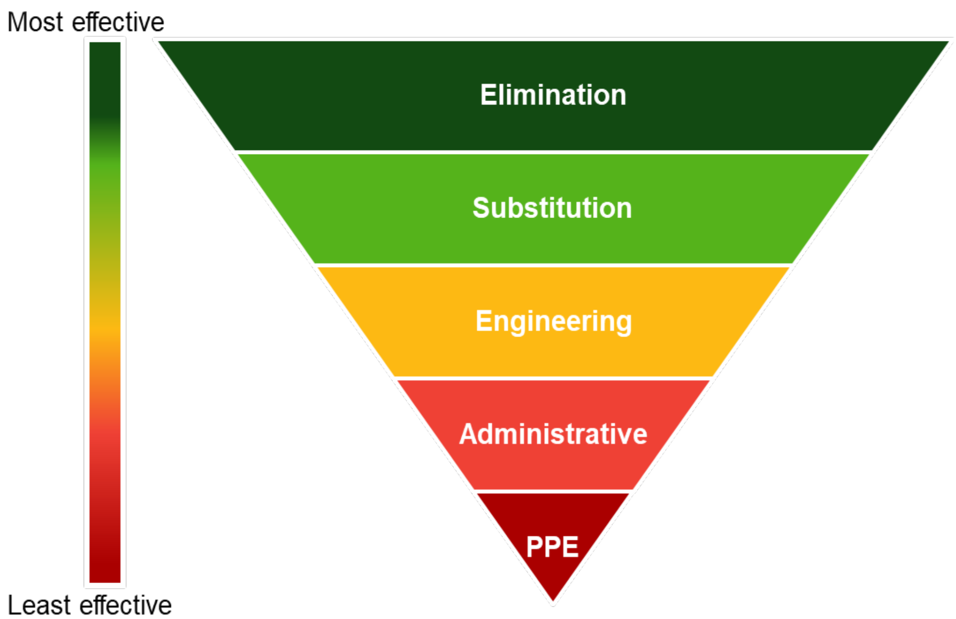

Figure 1: Hierarchy of Controls. Types of controls depicted in order of efficacy from elimination (most effective) to personal protective equipment (PPE; least effective). *Adapted from the National Institute for Occupational Safety and Health (NIOSH).*

Engineering Controls

Engineering controls are laboratory design elements (e.g., ventilation) and specialized equipment (e.g., fume hoods) that physically separate hazards from the environment and/or laboratory personnel. Engineering controls are an effective method of risk reduction when used properly. Faculty/supervisors should be knowledgeable and vigilant about the failure modes of engineering controls. All engineering controls must be maintained properly, inspected regularly and operated within their design limits.

Laboratory Design

Laboratory design must account for safety considerations in chemical storage and use.

- Surfaces must be non-permeable and chemical resistant.
- Air pressure should be negative relative to public areas (e.g., hallways, offices), and ventilation must be single pass.
- Safety showers and eyewash stations, when required, must be accessible with no more than 10 seconds of travel time (approximately 50 feet) and no intervening doors. The area around the eyewash and shower equipment must be kept clear of items that obstruct their use.

Safety Equipment

Fume hoods are the most common tool for preventing inhalation exposure to hazardous chemicals. Guidance for the proper use of fume hoods is provided in the Fume Hood Use SOP.

Additional equipment that may be employed depending on the risk assessment includes

- Gloveboxes, closed systems and other isolation devices;
- Air contaminant removal devices (e.g., cold traps, HEPA filters) to minimize contamination of exhaust ventilation to the exterior environment;
- Chemical storage cabinets for specific hazard classes (e.g., flammables, corrosives) and
- Secondary containment trays and bins.

Performance Verification of Engineering Controls

Engineering controls must function properly to protect the health and safety of laboratory personnel. Equipment is tested according to the following schedule:

Equipment	Testing Frequency (minimum)	Responsible Party
Eyewash	Annually (inspection)	Facilities Services
Eyewash	Weekly (activation)	Faculty/Supervisors
Safety Shower	Annually	Facilities Services
Fume Hood	Annually	TSS/Facilities Services
Fire Extinguisher	Annually	Facilities Services

Administrative Controls

Administrative controls reduce risk by changing the way individuals behave in the laboratory. Training, safe operating procedures, policies and behavioral standards (e.g., housekeeping) can reduce the probability of exposure to hazardous materials. However, unlike engineering controls, the efficacy of administrative controls relies entirely on individual action.

The following administrative controls are required in Seattle University laboratories:

- Only authorized individuals may access laboratories.

- Laboratory personnel receive task-specific training before performing activities that involve hazardous materials (see *Training*). Faculty/supervisors document training and retain training records.
- Safe operating procedures are available and followed for laboratory procedures involving hazardous materials (see *Safe Operating Procedures*).
- Hazardous waste is disposed of as described in *Hazardous Waste Management*.
- Activities that bring items to the face (e.g., eating, drinking, smoking, chewing gum, applying cosmetics) are reserved for outside of the laboratory.
- Pipetting or suctioning by mouth is prohibited.
- Every person entering a laboratory wears appropriate lab attire: long pants (or equivalent) and closed-toe shoes with no skin showing below the waist.
- Before leaving the laboratory, laboratory personnel wash hands with soap and water.

Additional laboratory safety and health procedures, including those specific to certain types of hazardous materials, are described in hazard- and chemical-specific SOPs.

Personal Protective Equipment (PPE)

PPE is the last line of defense against exposure to chemical hazards. Laboratory personnel must be trained on the selection, use, care and limitations of PPE. The PPE required for a procedure depends on the risk assessment but will usually provide body, hand and eye protection. PPE recommendations are available in a chemical's SDS, and more assistance is available from the faculty/supervisor or the ASO. Required PPE is provided to laboratory personnel at no charge.

Types of PPE

Considerations for eye and face protection:

- Eye and face protection must meet ANSI Z87.1 testing standards.
- Safety glasses with side shields are worn for impact protection. Chemical splash goggles are worn to protect against splashes to the eyes.
- Safety glasses and chemical splash goggles that fit over prescription glasses are available from most scientific vendors. Prescription safety glasses or goggles may also be available from specialized vendors.
- Face shields provide impact protection and some splash protection for the full face. Face shields should be worn over other eye protection options and not as a substitute.

Considerations for skin protection:

- Lab coats protect the arms and body from chemical splashes. Lab coat material (e.g., liquid resistant, flame retardant) should be selected based on the hazards and procedures. Lab coats with cuffs provide better protection in the wrist area than those without.
- Chemical-resistant gloves protect the hands from chemical contact. No single glove material can protect against all possible hazards—gloves should be selected based on the hazards and procedures. Glove selection guidance is available from NIOSH and in SDSs. Disposable gloves are intended for one-time use and must be disposed after removal and whenever noticeably contaminated.

- Chemical splash aprons, arm covers, head covers, full-body suits and other specialized PPE may be needed based on the risk assessment.

Considerations for respiratory protection:

- Air-purifying half-face or full-face respirators are used when necessary to maintain exposure below the permissible exposure limit (PEL).
- Laboratory personnel who require respirators must be annually trained, fit tested and medically cleared by a licensed healthcare provider. Information on enrolling in Seattle University's Respiratory Protection Program is available by contacting the ASO.

Ensuring PPE Performance

PPE must function properly to protect the health and safety of laboratory personnel. It is essential that laboratory personnel perform a visual inspection of PPE at each use and replace compromised items.

Particularly Hazardous Substances

Work with particularly hazardous substances—carcinogens, acute toxicants and reproductive toxicants—requires the following additional controls:

1. Establishment of designated areas
2. Use of a containment device such as a fume hood or glovebox
3. Safe handling and removal of waste
4. Decontamination procedures

STANDARD OPERATING PROCEDURES

General Health and Safety Procedures for Laboratories

General laboratory health and safety guidelines are described in *Controls*. Additional guidelines for specific procedures or for working with specific hazards are provided in the chemical SOPs library.

Laboratory-specific SOPs

Faculty/supervisors provide written SOPs for working with hazardous chemicals in teaching and research laboratories. The ASO reviews SOPs on request. Templates addressing specific hazard classes and common laboratory procedures are available in the SOP template library. Laboratory personnel must be trained on these SOPs, and training must be documented (see *Training*).

CHEMICAL MANAGEMENT

Signs and Labels

Manufacturer Labels

Manufacturers are required to label chemical containers with GHS-compliant labels that include the elements shown in **Figure 2**. Labels from the manufacturer or vendor must not be removed or defaced until the container is completely empty and triple rinsed. If the manufacturer label is damaged, a secondary label containing the elements in **Figure 2** may be created to replace it.

Lab-generated Containers

All containers of materials, including aliquots and solutions, in Seattle University laboratories must be labeled with the full name of the contents. Any unlabeled containers with material present are considered a safety risk, and the laboratory will be responsible for determining the contents or funding disposal as an unknown chemical (see *Hazardous Waste Management*).

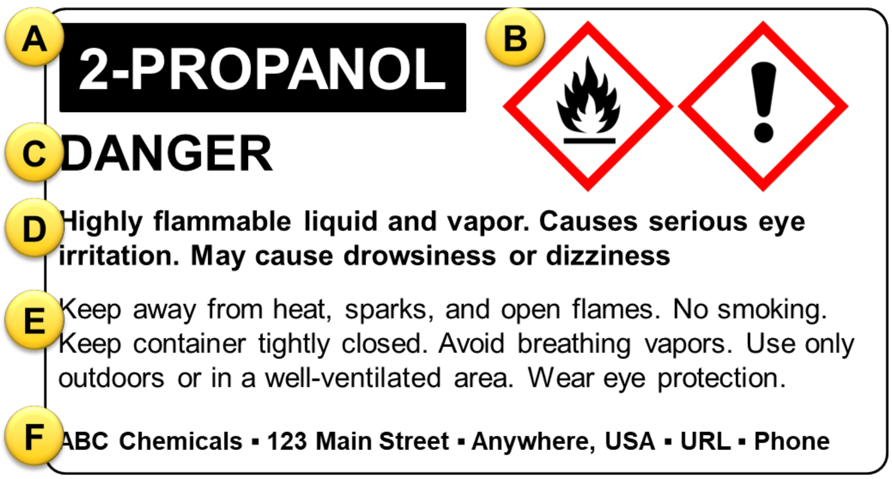

Figure 2: GHS-compliant Chemical Label Elements. A: Product identifier. **B:** GHS pictograms (*see* Table 1). **C:** Signal word ("Danger" or "Warning"). **D:** Hazard statements. **E:** Precautionary statements. **F:** Supplier contact information.

Peroxide-forming Chemicals

Peroxide-forming chemicals can degrade into shock-sensitive materials over time and must be used or disposed of within certain timeframes, typically 12 months from opening. If a lab can demonstrate that the peroxide former has not developed peroxides, the chemical may be stored beyond the storage timeframe. To facilitate tracking, peroxide-forming chemicals must be labeled with the date the container was received by the laboratory, the date the container was opened and any peroxide testing dates and results. Examples of peroxide-forming chemicals are listed in Appendix B.

If a peroxide-forming chemical of unknown age is found in the lab and/or has signs of crystallization, discoloration or liquid stratification (layering), **do not** handle the bottle. Notify others to avoid the area and place a Facilities Services work order for disposal.

Laboratory Door Signs

Entrances to areas where hazardous materials are stored or handled are labeled with door signs. Guidance to assist labs in completing door signs is available online. The laboratory is responsible for ensuring that the information on the sign is up to date.

Storage Cabinets and Equipment

Chemical storage cabinets for flammable liquids must be labeled "FLAMMABLE—KEEP FIRE AWAY"; cabinets for corrosive liquids must be labeled "Corrosives." Refrigerator and freezer units must be labeled "Not for flammable liquid storage" unless they are designed, certified and labeled as units for flammables storage.

Chemical Storage

Chemicals must be stored properly to prevent spills, accidental mixing of incompatible materials and the spread of fire. Incompatible chemicals must be stored in different cabinets (e.g., flammables and oxidizers) or separated using secondary containment (e.g., acids and bases). Specific incompatibilities and storage requirements are found in section 10 of a material's SDS. Examples of chemical incompatibilities are in Appendix C.

General guidelines for storing chemicals:

- Use a container that is chemically inert to the substance.
- Store stock quantities of hazardous chemicals in a secure area and in a manner that will not damage the container.
- Segregate incompatible chemicals in separate storage areas (cabinets) or using separate secondary containers.
- Store all chemical containers upright and directly on a surface (not stacked).
- Store corrosive liquid and toxic liquid chemicals in secondary containers.
- Secondary containers must be large enough to accommodate the volume of the largest container within them.
- A maximum of 10 gallons of flammable liquids may be stored outside of flammable liquid storage cabinets, flammable-approved refrigerators or safety cans.
- Domestic or normal laboratory type refrigerators/freezers must not be used to store flammable materials. Flammables can only be stored in refrigerators/freezers rated for flammable storage (flammables approved or explosion proof).
- Minimize flammable amounts in work areas and keep flammables away from heat sources.

Chemical Inventory

A list of chemicals, including their container sizes and physical states, must be available for each location where hazardous materials are handled and stored to meet Seattle Fire Code requirements. The ChemTracker module in BioRAFT is available to help laboratories create and maintain chemical inventories. Faculty/supervisors are responsible for ensuring that chemical inventories are up to date.

HAZARD INFORMATION AND TRAINING

Hazard Information

Multiple resources are available to inform laboratory personnel about the chemical hazards present in their work areas, including the following:

- *Hazardous Chemicals in Laboratories*, L&I WAC 296-828. This regulation addresses the health and safety considerations for laboratory personnel working with or around hazardous chemicals.
- Seattle University Chemical Hygiene Plan. WAC 296-828 requires employers to have a written CHP. The Seattle University CHP fulfills this requirement and is a resource for laboratory personnel to utilize in planning experiments.
- *Permissible Exposure Limits for Airborne Contaminants*, L&I WAC 296-841-20025. L&I establishes PELs for many chemicals. If a PEL has not been established for a specific chemical, contact the ASO for guidance.
- Reference materials on hazard classification, signs and symptoms of exposure, safe handling, storage and disposal.
  - Safety Data Sheets: Faculty/supervisors are responsible for ensuring that SDSs are readily available. Electronic SDSs are available online and from chemical manufacturers.
  - PubChem: The National Institutes of Health provide a searchable chemistry database with health, safety and toxicity data and other useful information.
  - TOXNET: The National Library of Medicine maintains a searchable toxicology data network with toxicology, hazardous chemical, environmental health and toxic release databases.

Training

Faculty/supervisors or their designees are responsible for providing training to laboratory personnel and ensuring they understand the hazards of the chemicals they work with or around. General chemical hygiene training is available from the ASO but must be supplemented by laboratory-specific training on procedures and materials.

Recordkeeping

Safety training must be documented. The ASO maintains records of general safety trainings provided. Faculty/supervisors or their designees maintain laboratory-specific training records, including the trainee’s name, the trainer’s name, the date of the training and the topic(s) covered.

Lab-specific training can be documented using the Workplace Safety Orientation form or another method of choice.

HAZARDOUS WASTE MANAGEMENT

Management of hazardous chemical waste is a critical health, safety and environmental protection responsibility of the laboratory. Hazardous waste includes all materials that are ignitable, corrosive, reactive, toxic and/or environmentally persistent. The Hazardous Waste Program through EHS ensures that hazardous chemical wastes are properly collected, packaged, shipped and disposed. A detailed definition of hazardous waste and requirements for disposal are covered in the Regulated Waste Management policy.

Because waste management begins with procurement, laboratories are encouraged to purchase the smallest quantities feasible to minimize waste. Materials must be clearly identified for disposal; costs associated with identifying unknowns may be recharged.

EMERGENCY RESPONSE

All incidents involving exposure to or release of hazardous chemicals require prompt action to minimize effects on health, the environment and property. General emergency response guidelines are available from the Department of Public Safety.

Chemical Exposures

Immediate response to chemical exposures can minimize health and safety effects. Initial first aid treatment varies with route of exposure, as outlined in the exposure response procedure below:

1. Alert others nearby
2. Follow route of exposure guideline:
   - **Minor Skin Contact**: Rinse affected area with water for at least 15 minutes
   - **Exposure to Body, Eyes or Clothing**: Remove contaminated clothing and rinse affected area with water for at least 15 minutes at the safety shower or eyewash station
   - **Inhalation or Ingestion**: Evacuate to fresh air
3. Call x5911 (206-296-5911) to notify Public Safety
4. Notify supervisor and the ASO
5. Consult the SDS
6. Obtain medical attention if necessary

Chemical Spills

If a spill results in contact with or potential exposure to the spilled material, follow the **Chemical Exposures** procedure above.

Spill response varies significantly with the characteristics of the spilled material, the amount of material released, the location of the spill and the experience of the person(s) involved. A chemical spill **should not** be cleaned by laboratory personnel and is considered an **emergency** if any of the following is true:

- The substance or hazards are unknown
- The chemical is strongly reactive or explosive

- The spill poses an inhalation hazard and is outside of a fume hood or glovebox
- The spill occurs in a public area (e.g., hallway, elevator)

Laboratory personnel who have not been trained to respond to spills should not attempt to clean a spill. General spill response steps are outlined below.

If the spill is an **emergency**:

1. Alert others nearby
2. Evacuate the area
3. Contact Public Safety at x5911 (206-296-5911)
4. Notify supervisor and the ASO

If the spill is **not** an emergency:

1. Alert others nearby
2. Contain the spill (e.g., by closing the fume hood sash or righting an overturned bottle) if possible without contacting the material
3. Assess the spill, the potential for exposure and your knowledge of spill response, and review the chemical's SDS
4. Initiate spill cleanup based on the assessment:
    - If you are not trained or comfortable cleaning the spill, call Public Safety at x5911 (206-296-5911)
    - If the spill enters a drain or waterway or contacts soil, call Public Safety at x5911 (206-296-5911)
    - If you are trained, comfortable, and have the correct supplies, clean the spill following your laboratory's SOPs
5. Notify your faculty or supervisor and the ASO

MEDICAL CONSULTATION, EXAMINATION AND SURVEILLANCE

Laboratory personnel who work with hazardous chemicals will be provided the opportunity to receive medical attention/consultation when

- They report symptoms or signs of exposure associated with a hazardous chemical that they may have been exposed to in the laboratory,
- Exposure evaluation reveals an overexposure,
- A spill, leak or other occurrence results in a hazardous exposure (potential overexposure) or
- A medical provider recommends a follow-up evaluation.

Exposure Evaluation

Exposure evaluation is conducted if there is reason to believe that exposure levels for a substance exceed the action level (or in the absence of an action level, the PEL), e.g., if laboratory personnel develop signs or symptoms associated with hazardous chemical exposure. The initiation, frequency and termination of exposure evaluation adhere to the relevant regulation.

Monitoring results are provided to the affected individual within the time limits of the relevant regulation or within five (5) business days of receipt of monitoring results. The ASO maintains copies of exposure monitoring results according to regulatory requirements.

Medical Examinations

Medical examinations will be conducted by a licensed healthcare professional (LHCP).

In the event of an exposure, the faculty/supervisor will provide the following information to the LHCP:

- Identity of hazardous chemical(s),
- Conditions of exposure, including exposure data, if available and
- Signs and symptoms of exposure.

Seattle University's Human Resources Department will obtain a written report from the LHCP that includes

- Recommendations for further medical follow-up,
- Medical condition(s) that may place the employee at increased risk from exposure to a hazardous chemical and
- A statement that the employee has been informed of the results.

The written report shall not reveal specific findings or diagnoses unrelated to occupational exposure.

Human Resources is responsible for informing the faculty/supervisor of any work modifications ordered by the LHCP as a result of exposure.

Recordkeeping and Record Access

Medical records will be maintained in accordance with regulatory requirements. Personnel may access their personal medical records by contacting Human Resources at hr@seattleu.edu.

Appendix A: Definitions and Acronyms

Action Level – The exposure level (concentration of the material in air) at which regulations to protect employees take effect

Acute Toxin – A chemical that causes severe and immediate health effects from limited exposure, falling within any of the following categories:

- Oral LD_{50} ≤50 mg/kg in rats weighing 200–300 g each
- Dermal LD_{50} ≤200 mg/kg in rabbits weighing 2–3 kg each when administered by continuous contact for 24 hours
- Inhalation LC_{50} ≤500 ppm (gas), ≤2 mg/L (vapor) or ≤0.5 mg/L (mist, fume or dust) when administered continuously for 4 hours to rats weighing 200–300 g each

ANSI – American National Standards Institute

ASO – Academic Safety Officer

Carcinogen – Chemicals that may cause cancer, typically after repeated or chronic exposure. Their effects may only become evident after a long latency period and may cause no immediate harmful effects. Chemicals are considered select carcinogens if they meet one of the following criteria:

- Regulated by WISHA as a carcinogen (WAC 296-62-073)
- Listed in the "known to be carcinogens" or "reasonably anticipated to be carcinogens" categories in the National Toxicity Program Annual Report on Carcinogens
- Listed in Group 1, 2A or 2B by the International Agency for Research on Cancer

CFR – Code of Federal Regulations

Chemical Hygiene Officer – An employee designated by the employer who is qualified by training or experience to provide technical guidance in the development and implementation of the chemical hygiene plan; Seattle University's Academic Safety Officer is the Chemical Hygiene Officer

Chemical Hygiene Plan – A written program that establishes policy and procedures capable of protecting employees from the health hazards of the chemicals used in the laboratory

CHP – Chemical Hygiene Plan

DOSH – Division of Occupational Safety and Health, part of the Department of Labor and Industries (L&I)

EHS – Environmental Health and Safety

Emergency – Any occurrence such as, but not limited to, equipment failure, container rupture or control equipment failure that could or does result in an uncontrolled release of a hazardous chemical into the workplace

Environmental Hazard – A material with demonstrated toxicity to aquatic organisms

Exposure – Contact with a hazardous substance through various routes of entry (e.g., inhalation, ingestion, skin contact, skin absorption) with or without protection from PPE

GHS – United Nations' Globally Harmonized System of Classification and Labelling of Chemicals

Globally Harmonized System for Hazard Communication – L&I WAC 296-901; regulation intended to address chemical hazard classification, hazard communication and employee protective measures

Hazard Assessment – Determination of the potential health, physical and chemical hazards associated with an experiment before beginning it

Hazardous Chemicals in Laboratories – L&I WAC 296-828; regulation applicable to the laboratory use of hazardous chemicals

Health Hazard – A chemical classified as posing one of the following hazardous effects: acute toxicity (any route of exposure), skin or eye corrosion or irritation, respiratory or skin sensitization, germ cell mutagenicity, carcinogenicity, reproductive toxicity, or specific target organ toxicity (single or repeated exposure)

HEPA Filter – High-efficiency particulate air-purifying filter

Incompatible – Materials that could cause dangerous reactions by direct contact with one another

L&I – Washington State Department of Labor and Industries; L&I is a governmental agency that protects worker health and safety in Washington State.

Laboratory – A workplace where relatively small amounts of hazardous substances are used on a nonproduction basis

LC_{50} – Median lethal concentration: the concentration of a chemical in air that kills 50% of test animals during an observation period

LD_{50} – Median lethal dose: the amount of a chemical which causes the death of 50% of test animals when administered at one time

LHCP – Licensed healthcare professional

Listed Carcinogen – A carcinogen specifically listed in WAC 296-62-07304

Nanomaterial – Material consisting of particles with at least one dimension of 1–100 nanometers

NIOSH – National Institute for Occupational Safety and Health, US Public Health Service, US Department of Health and Human Services

Particularly Hazardous Substance – A select carcinogen, reproductive toxin or substance that has a high degree of acute toxicity

PEL – Permissible exposure limit

Permissible Exposure Limit – An employee exposure limit established via WISHA's regulatory authority that must not be exceeded

Personnel – Staff, faculty, students and volunteers employed by Seattle University in part-time and full-time paid positions

Physical Hazard – A chemical for which there is scientifically valid evidence that it is explosive, flammable, oxidizing, self-reactive, pyrophoric, self-heating, an organic peroxide, corrosive to metal, a compressed gas, water-reactive or a combustible dust

PPE – Personal protective equipment

Reproductive Toxin – A chemical which affects the reproductive system and may produce chromosomal damage (mutation) and/or adverse effects on the fetus (embryolethality or teratogenesis)

Respirator – Device that will protect the wearer's respiratory system from overexposure by inhalation to airborne contaminants and is used when a worker might be exposed to concentrations exceeding the PEL

Safety Data Sheet – Written, printed or electronic information that informs manufacturers, distributors, employers or employees about a hazardous substance, its hazards and protective measures as required by WAC 296-901-14014

SDS – Safety data sheet

Secondary container – A system, device or control measure (most commonly a storage bin) that is used to segregate incompatible materials and prevent the spread of a spill

SOP – Standard operating procedure

WAC – Washington Administrative Code

WISHA – Washington Industrial Safety and Health Act; enforced by the Division of Occupational Safety and Health (DOSH) in the Department of Labor and Industries (L&I)

Appendix B: Peroxide-forming Chemicals

Table 2: Classes of Peroxidizable Chemicals

A. Chemicals that form explosive levels of peroxides without concentration

Butadiene[a]	Divinylacetylene	Tetrafluoroethylene[a]	Vinylidene chloride
Chloroprene[a]	Isopropyl ether		

B. Chemicals that form explosive levels of peroxides on concentration

Acetal	Decahydronaphthalene	2-Hexanol	1-Phenylethanol
Acetaldehyde	Diacetylene	Methylacetylene	2-Phenylethanol
Benzyl alcohol	Dicyclopentadiene	3-Methyl-1-butanol	2-Propanol
2-Butanol	Diethyl ether	Methylcyclopentane	Tetrahydrofuran
Cumene	Diethylene glycol dimethyl ether (diglyme)	Methyl isobutyl ketone	Tetrahydronaphthalene
Cyclohexanol	Dioxanes	4-Methyl-2-pentanol	Vinyl ethers
2-Cyclohexen-1-ol	Ethylene glycol dimethyl ether (glyme)	2-Pentanol	Other secondary alcohols
Cyclohexene	4-Heptanol	4-Penten-1-ol	

C. Chemicals that may autopolymerize as a result of peroxide accumulation

Acrylic acid[b]	Chlorotrifluoroethylene	Vinyl acetate	Vinyladiene chloride
Acrylonitrile[b]	Methyl methacrylate[b]	Vinylacetylene	
Butadiene[c]	Styrene	Vinyl chloride	
Chloroprene[c]	Tetrafluoroethylene[c]	Vinylpyridine	

D. Chemicals that may form peroxides but cannot clearly be placed in sections A–C

Acrolein	*tert*-Butyl methyl ether	Di(1-propynyl) ether[f]	*n*-Methylphenetrole
Allyl ether[d]	*n*-Butyl phenyl ether	Di(2-propynyl) ether	2-Methyltetrahydrofuran
Allyl ethyl ether	*n*-Butyl vinyl ether	Di-*n*-propoxymethane[d]	3-Methoxy-1-butyl acetate
Allyl phenyl ether	Chloroacetaldehyde diethylacetal[d]	1,2-Epoxy-3-isopropoxypropane[d]	2-Methoxyethanol
p-(*n*-Amyloxy)benzoyl chloride	2-Chlorobutadiene	1,2-Epoxy-3-phenoxypropane	3-Methoxyethyl acetate
n-Amyl ether	1-(2-Chloroethoxy)-2-phenoxyethane	*p*-Ethoxyacetophenone	2-Methoxyethyl vinyl ether

Benzyl *n*-butyl ether[d]	Chloroethylene	1-(2-Ethoxyethoxy)ethyl acetate	Methoxy-1,3,5,7-cyclooctatetraene
Benzyl ether[d]	Chloromethyl methyl ether[e]	2-Ethoxyethyl acetate	beta-Methoxypropionitrile
Benzyl ethyl ether[d]	Beta-Chlorophenetole	(2-Ethoxyethyl)-*o*-benzoyl benzoate	*m*-Nitrophenetole
Benzyl methyl ether	*o*-Chlorophenetole	1-Ethoxynaphthalene	1-Octene
Benzyl 1-naphthyl ether[d]	*p*-Chlorophenetole	*O*,*p*-Ethoxyphenyl isocyanate	Oxybis(2-ethyl acetate)
1,2-Bix(2-chloroethoxy)ethane	Cyclooctene[d]	1-Ethoxy-2-propyne	Oxybis(2-ethyl benzoate)
Bis(2-ethoxyethyl) ether	Cyclopropyl methyl ether	3-Ethoxyopropionitrile	beta,beta-Oxydipropionitrile
Bis(2-(methoxyethoxy)ethyl) ether	Diallyl ether[d]	2-Ethylacrylaldehyde oxime	1-Pentene
Bis(2-chloroethyl) ether	*p*-Di-*n*-butoxybenzene	2-Ethylbutanol	Phenoxyacetyl chloride
Bis(2-ethoxyethyl) adipate	1,2-Dibenzyloxyethane[d]	Ethyl beta-ethoxypropionate	alpha-phenoxypropionyl chloride
Bis(2-ethoxyethyl) phthalate	*p*-Dibenzyloxybenzene[d]	2-Ethylhexanal	Phenyl *o*-propyl ether
Bis(2-methoxyethyl) carbonate	1,2-Dichloroethyl ethyl ether	Ethyl vinyl ether	*p*-Phenylphenetone
Bis(2-methoxyethyl) ether	2,4-Dichlorophenetole	Furan	*n*-Propyl ether
Bis(2-methoxyethyl) phthalate	Diethoxymethane[d]	2,5-Hexadiyn-1-ol	*n*-Propyl isopropyl ether
Bis(2-methoxymethyl) adipate	2,2-Diethoxypropane	4,5-Hexadien-2-yn-1-ol	Sodium 8,11,14-eicosatetraenoate
Bis(2-*n*-butoxyethyl) phthalate	Diethyl ethoxymethylene malonate	*n*-Hexyl ether	Sodium ethoxyacetylide[f]
Bis(2-phenoxyethyl) ether	Diethyl fumarate[d]	*O*,*p*-Iodophenetole	Tetrahydropyran
Bis(4-chlorobutyl) ether	Diethyl acetal[d]	Isoamyl benzyl ether[d]	Triethylene glycol diacetate
Bis(chloromethyl) ether[e]	Diethylketene[f]	Isoamyl ether[d]	Triethylene glycol dipropionate
2-Bromomethyl ethyl ether	*m*,*o*,*p*-Diethoxybenzene	Isobutyl vinyl ether	1,3,3-Trimethoxypropene[d]

beta-Bromophenetole	1,2-Diethoxyethane	Isophorone[d]	1,1,2,3-Tetrachloro-1,3-butadiene
o-Bromophenetole	Dimethoxymethane[d]	beta-Isopropoxypropionitrile[d]	4-Vinyl cyclohexene
p-Bromophenetole	1,1-Dimethoxyethane[d]	Isopropyl 2,4,5-trichlorophenoxy-acetate	Vinylene carbonate
3-Bromopropyl phenyl ether	Dimethylketene[f]	Limonene	Vinylidene chloride[d]
1,2-Butadiyne	3,3-Dimethoxypropene	1,5-*p*-Methadiene	
Buten-3-yne	2,4-Dinitrophenetole	Methyl *p*-(*n*-amyloxy)benzoate	
tert-Butyl ethyl ether	1,3-Dioxepane[d]	4-Methyl-2-pentanone	

[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 autopolymerize as a result of peroxide accumulation.

[d] These chemicals easily form peroxides and should probably be considered under Part B.

[e] OSHA-regulated carcinogen.

[f] Extremely reactive and unstable compound.

Table 3: Safe storage period for peroxide formers

Description	Period
Unopened chemicals from manufacturer	18 months
Opened containers	
Chemicals in Part A, Table 1	3 months
Chemicals in Parts B and D, Table 1	12 months
Uninhibited chemicals in Part C, Table 1	24 hours
Inhibited chemicals in Part C, Table 1	12 months[a]

[a] Do not store under inert atmosphere

Source: Kelly, RJ. 1996. Chem Health & Safety. 3(5):28.

Appendix C: Chemical Incompatibility

When transporting, storing, using or disposing of any substance, exercise utmost care to ensure that the substance cannot accidentally contact another with which it is incompatible. Such contact can result in an explosion or the formation of substances that are highly toxic, flammable or both. **Table 4A** is a general guide for determining incompatible substances. **Table 4B** provides specific examples of incompatible chemicals. Neither table is intended to be comprehensive, and SDSs should always be consulted to determine specific incompatibilities.

Table 4: Chemical Incompatibility Guidance

A. General Hazard Class Incompatibilities.

In general, the pairs of hazard classes marked with an **X** are incompatible with one another.

	Flammable Liquids	Oxidizers	Organic Acids	Inorganic Acids	Bases	Water Reactives	Aqueous Solutions	Cyanides
Flammable Liquids		X		X				
Oxidizers	X		X					
Organic Acids		X		X	X	X		X
Inorganic Acids	X		X		X	X		X
Bases			X	X				
Water Reactives			X	X			X	
Aqueous Solutions						X		X
Cyanides			X	X			X	

B. Specific Examples of Incompatible Chemicals

Chemical	Incompatible with
Acetic acid	Chromic acid, nitric acid, perchloric acid, peroxides, permanganates
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Acetone	Concentrated nitric acid and sulfuric acid mixtures

Chemical	Incompatible with
Alkali and alkaline earth metals	Water, carbon tetrachloride or other chlorinated hydrocarbons, i.e., powdered aluminum or magnesium carbon dioxide, halogens, calcium, lithium, sodium, potassium
Ammonia (anhydrous)	Mercury, chlorine, calcium hypochlorite, iodine, bromine, anhydrous HF
Ammonium nitrate	Acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organics or combustibles
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Bromine	See Chlorine
Calcium oxide	Water
Carbon (activated)	Calcium hyperchlorite, all oxidizing agents
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzene, finely divided metals, turpentine
Chlorine Dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids
Decaborane	Carbon tetrachloride and some other halogenated hydrocarbons
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	Everything
Hydrocarbons (such as butane, propane)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrocyanic acid	Nitric acid, alkali
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)

Chemical	Incompatible with
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitrates	Sulfuric acid
Nitric acid (concentrated)	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, brass, any heavy metals
Nitrates	Acids
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver, mercury
Oxygen	Oils; grease; hydrogen; flammable liquids, solids or gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
Peroxides, organic	Acids (organic or mineral), friction, heat
Phosphorous (white)	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids
Potassium perchlorate (also chlorates)	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Selenides	Reducing agents
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, water
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfural

Chemical	Incompatible with
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals such as sodium, lithium)
Tellurides	Reducing agents

Source: Caltech Chemical Hygiene Plan