Chemical Hygiene Plan

Idaho State University | Evironmental Health, Safety, and Sustainability

Effective Date: May 2023

(208) 282-2310
isu.edu/ehs

ROAR

Revision	Date	Description of Change	Editor
001	10/2019	Revision	Nancy Fox/Clark Weaver
002	5/2023	Revision	Jennifer Parrott

Table of Contents

1.0 Purpose

Idaho State University recognizes the importance of the prudent acquisition, storage, use and management of laboratory chemicals to protect people property, the environment and to support academic and research activities. The purpose of the Chemical Hygiene Plan (CHP or plan) is to ensure safety and health by limiting occupational exposures to hazardous chemicals in the laboratory. It is the responsibility of all persons working in university laboratories to be familiar with and perform work consistent with the provisions of this plan.

2.0 Scope

The CHP applies to all chemical use in laboratories in Idaho State University facilities. Chemical safety in non-laboratory work environments is covered by the Hazard Communication Standard.

3.0 Responsibilities

Chemical Hygiene Officer (CHO)

- Resides in the Environmental Health, Safety and Sustainability (EHSS) Department.
- Assists laboratory personnel and department heads in providing a safe laboratory environment
- Provides assistance to laboratory personnel and department heads in maintaining compliance with chemical health and safety regulations and recognized best practices.
- Coordinates the evaluation, annual review and revision of the CHP
- Coordinates laboratory safety consultations
- Provides and coordinates chemical hygiene/safety training
- Assists in the selection of personal protective equipment (PPE) and proper use
- Acts as a liaison with regulatory agencies
- Assists laboratory personnel in conducting hazard assessments
- Provides assistance in the investigation of all reports of laboratory hazardous incidents, chemical spills and near misses
- Performs workplace evaluations which may include exposure monitoring to evaluate personnel exposure levels to chemicals
- Leads the investigation of exposure complaints or concerns for medical consultations referral or exposure monitoring
- Assists laboratory personnel with proper disposal of chemicals
- Performs laboratory close outs when laboratory personnel leave

EHSS has the authority to restrict access to a laboratory in accordance with ISUPP 1070.

Leadership of Departments and Units

- Promote and support safety and health in laboratories under their purview
- Support compliance with this CHP by faculty and staff within their respective areas

Laboratory Safety Coordinator

- Designated at the Departmental or college level
- Work with the CHO to implement this plan within their respective college or unit
- Assist in the dissemination of laboratory safety information
- Serve as a chemical safety liaison between the respective college or unit with EHSS
- Participate and provide laboratory safety trainings and workshops

Laboratory Safety Committee(s)

Each college or unit with chemical laboratories should establish and maintain a safety committee. The safety committee will ensure that research and academic laboratory tasks are planned and executed safely and consistently with this Plan. The Laboratory Safety Coordinator shall serve as the Chair of the safety committee. Roles and responsibilities for these committees include:

- Provide recommendations and assistance with developing safe work practices and procedures
- Ensure employees and students have knowledge of safety policies and procedures
- Identify potential hazards presented by laboratory activities and encourage safety analyses and developments of standard operation procedures (SOPs) to mitigate risk
- Provide assistance in the training and proper use of personal protective equipment (PPE) and ensure PPE is provide and used
- Investigate and document incidents of accident/injury/exposure and recommend methods for prevent.
- Assist with developing research protocols or SOPs for hazard identification and safety requirements
- Communicate concerns upward

Principal Investigators (PIs) and Laboratory Managers

- Ensure that all safety policies and procedures outlined in this Plan are followed by personnel working under their direction.
- Train personnel in safe work practices appropriate to their work and projects
- Oversee laboratories including the equipment, practices, procedures and techniques employed.
- Ensure laboratory workers are working in a safe environment.
- Maintain a safe and healthful working environment, by identifying hazards in the laboratory and selecting the most appropriate controls to protect health and safety of workers.
- Ensure all work performed in the laboratory is conducted in accordance with the CHP and other applicable university policies and programs.
- Review compliance and discrepancies in safety performance as necessary, and work toward resolution of such issues to ensure that safe practices and techniques are continuously being employed.
- Review accident reports, share lessons learned and make recommendations for future procedures or practices to minimize the repetition of similar types of accidents.
- Maintain an accurate chemical inventory preferably in the University's chemical inventory system
- Establish supplemental training and SOPs for the laboratory.
- Provide oversight that helps ensure employees are properly trained and understand procedures applicable to safety in their laboratories and work areas.
- Provide required personal protective equipment to laboratory workers and ensure proper use.
- Maintain a Laboratory Specific Safety Plan (Appendix D)

Laboratory Workers (Including Students)

- Understand and follow all laboratory safety related policies, programs, procedures and training received.
- Know the physical and health hazards, handling procedures and emergency response information for the chemicals and tasks used as part of their research.
- Understand the function and proper use of all PPE and wear required PPE when appropriate.

- Promptly report all work-related incidents, injuries and illnesses to their supervisor and Risk Management. Report near misses, potential serious safety issues or environmental contamination to EHSS.
- Contact the lab supervisor/PI or CHO for further clarification if any of the above information or procedures are not clearly understood.

4.0 Regulatory Basis

This plan is based off of the Occupational Safety and Health Administration's (OSHA) Occupational Exposure to Hazardous Chemicals in Laboratories standard (29 CFR 1910.1450).

5.0 Training Requirements

All laboratory workers must read and understand this plan and complete required training prior to the start of any laboratory work.

Chemical Hygiene and Safety Training

Chemical Hygiene and Safety Training is available from the EHSS Department. An online course is available for self-enrollment on Moodle. To self-enroll for this training in Moodle, select site home on the left side-bar of Moodle, then scroll down to search courses, and search for EHS, and select EHS - 01 Chemical Hygiene & Laboratory Hazard Communication.

Laboratory supervisors or PIs may assign additional training based on the types of hazards present in the work area.

Hazardous Waste Generator Training

All employees and students who generate and manage hazardous waste must complete Hazardous Waste Generator training, **prior** to generating and managing hazardous waste at any university facility. Training is available through the EHSS Department. There is an annual refresher training requirement for hazardous waste generator training.

Laboratory Specific Training

The PI or Laboratory Manager must provide laboratory workers with training on the operations and safety requirements unique to their laboratory, specific projects, procedures, protocols, hazards of chemicals utilized in the laboratory. Training should include familiarization with chemical safety instruction, safety data sheets, hazard labeling, waste handling and other forms of information prior to using the chemicals. Training should satisfy the hazard awareness requirements and be documented including:

- The name of the chemical and its hazardous component(s);
- The health and physical risk(s) associated with the chemical;
- Signs of release and symptoms of exposure;
- How and when to use engineering controls and personal protective equipment;
- Labeling and storage requirements;
- Disposal procedures;
- Emergency procedures for spills and exposures; and
- Laboratory SOPs.

The majority of the hazard awareness information above is contained in the Safety Data Sheet.

All laboratory workers will be trained on the Laboratory Specific Safety Plan. This includes safety requirements of the laboratory and the bulleted items above.

6.0 Hazard Identification

Chemical Container Labeling

A chemical container label is the primary means for communicating the contents of a container and its hazard(s). Every container, even those just containing water, must be labeled to ensure employees and students are aware of its contents.

Original Container

Chemicals in original vendor containers must have labels indicating the chemical or product name and the vendor's name. Hazard warning signs or symbols should be prominently visible on the labels.

Secondary Container

All containers of chemicals decanted from an original container or prepared in the laboratory must be labeled with the chemical or product name(s) and primary hazard(s). This includes containers of reaction products or byproducts as well as separation processes such as distillations and extractions. The percentage of individual constituents will be included on the label.

Expiration Date

Time sensitive chemicals (e.g., peroxide formers) must be labeled with an appropriate expiration date, date opened and date tested for presence of unstable peroxides. All peroxide forming chemicals must be tested for peroxide formers every 3 months. An SOP for peroxide forming chemicals is available on the EHSS website. See Appendix B: Chemical Storage and Segregation for more information.

Waste Containers

All containers of chemical waste must be labeled. If the waste chemical is a hazardous waste, containers must be labeled with the words "Hazardous Waste", the full name of the chemical(s), and an indication of the primary hazard. Labels are available from EHSS or can be printed from the Hazardous Waste management Plan on the EHSS web site.

OSHA Globally Harmonized Hazard Communication Standard (HCS/GHS)

The Globally Harmonized System provides a standard for the labeling of chemical containers, classification of chemical hazards and the distribution of the information in a standardized manner. Included are pictograms that indicate the hazard(s) of a chemical, a new format for Safety Data Sheets (SDSs) and a simplification of the signal words used in labeling. These changes improve quality and consistency in the classification and labeling of all chemicals and enhance worker comprehension.

HCS/GHS Pictograms

Health Hazard	Flame	Exclamation Mark
		
• Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	• Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides	• Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful) • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non-Mandatory)
Gas Cylinder	**Corrosion**	**Exploding Bomb**
		
• Gases Under Pressure	• Skin Corrosion/Burns • Eye Damage • Corrosive to Metals	• Explosives • Self-Reactives • Organic Peroxides
Flame Over Circle	**Environment (Non-Mandatory)**	**Skull and Crossbones**
		
• Oxidizers	• Aquatic Toxicity	• Acute Toxicity (fatal or toxic)

Safety Data Sheets (SDS)

An SDS is a document prepared by a supplier to summarize the health and safety information associated with a product. Manufacturers and suppliers are required to provide an SDS for each chemical they make or offer. As required by OSHA, each SDS must contain the following sections:

- Identification
- Hazard(s) identification
- Composition/ information on ingredients
- First-aid measures
- Fire-fighting measures
- Accidental release measures
- Handling and storage
- Exposure controls/personal protection

- Physical and chemical properties
- Stability and reactivity
- Toxicological information
- Ecological information
- Disposal considerations
- Transport information
- Regulatory information
- Other information

Obtaining an SDS

An SDS typically accompanies a chemical shipment or is mailed separately. Companies may be contacted via phone or mail to obtain one, but many SDSs are online or may be requested via company websites. EHSS maintains a chemical inventory system that allows students, faculty and staff to look up SDSs. If you cannot find an SDS in the chemical inventory system, please contact EHSS.

Chemical Inventory

Each PI or Laboratory Manager is responsible for maintaining an inventory of chemicals in the laboratory. This inventory should be up to date and updated at least annually. The inventory shall contain every chemical used in the laboratory. SDSs must be readily accessible to any laboratory user.

Laboratory Door Signage

Laboratories must have a sign posted on the door that clearly identifies potential laboratory hazards and entry requirements. The sign informs laboratory staff and visitors of proper PPE and safety measures and may aid first responders. The sign must also include emergency contact information, PI or Laboratory Manager and room number.

Laboratory signs should be updated as needed and reviewed annually by the PI or Laboratory Manager. Laboratory signage should be consistent across all laboratories and signage templates are available through EHSS.

Safety Equipment Signage

Signage must be visible for indicating the location of eyewashes and safety showers. The area around and path to the eyewashes and safety showers must be kept clear. Signage must also identify the location of fire blankets, fire extinguishers, spill kits, and any other safety equipment by name or an appropriate symbol. Access to all safety equipment must be unobstructed (at least 30 inches of clear access from the safety equipment).

Particularly Hazardous Substances (PHSs)

Particularly Hazardous Substance are defined as a select carcinogens, reproductive toxins or substances with a high degree of acute toxicity.

Use of any PHS requires:

- Establishment of a designated area
- Use of appropriate containments devices such as fume hoods or gloves boxes;
- Standard Operating Procedures for safe handling of the PHS and for the needed disposal of resulting waste materials
- Decontamination procedures

OSHA requires that the room or area where work with PHSs is performed to be posted with a ***Designated Area*** sign. The posting of an established “designated area” identifies areas of higher health risk. In some laboratories, it is appropriate to establish the entire room as a “designated area.” In other laboratories, a work bench or fume hood is more appropriate.

The controls and SOPs used to minimize exposures to PHSs must be documented in the Laboratory Specific Safety Plan. Information on SOPs and sample templates are available on the EHS web site.

7.0 Occupational Toxicology

Routes of Entry

To evaluate the risks of adverse health effects from chemicals, one must be aware of the routes of entry into the body, duration of exposure, toxicity of the chemical, exposure limits, and odor threshold of the chemical. This section explains these principles and describes how to reduce chemical exposure.

- **Inhalation** – The most common route of chemical exposure in the laboratory. Exposure by this route can produce poisoning by absorption through the mucous membrane of the nasal passage, mouth, throat and lungs and can seriously damage these tissues. Inhaled gases or vapors may pass rapidly into the capillaries of the lungs and be carried into the circulatory system. Exposure can be minimized by keeping containers closed when not in use, proper storage and the use of engineering controls (e.g., fume hood). Respiratory protection may be necessary if engineering controls cannot be used or do not provide sufficient protection. Laboratory users who wear respirators must be enrolled in the

Respiratory Protection Program.

- **Skin and Eye Contact** - Contact with the skin is the second most frequent route of chemical exposure. A common result of skin contact is localized irritation. Many materials are absorbed through the skin and quickly pass into the underlying blood vessels where they are carried through the blood stream and may cause systemic poisoning. The main routes of entry for chemicals through the skin are the hair follicles, sebaceous glands, sweat glands and cuts or abrasions of the outer layers of the skin. The follicles and the glands are abundantly supplied with blood vessels, which facilitate the absorption of many chemicals. Skin and eye contact with chemicals can be avoided by the use of appropriate personal protective equipment. At a minimum, wear a lab coat, the appropriate chemical-resistant gloves and safety glasses with side shields when working with hazardous chemicals. For more information, contact EHSS
- **Ingestion** - Chemicals used in the laboratory can be extremely dangerous if they enter the mouth and are swallowed. In addition, some chemicals may damage the tissues of the mouth, nose, throat, lungs and gastrointestinal tract producing systemic poisoning if absorbed through these tissues. To prevent entry of chemicals into the mouth, laboratory workers should wear gloves and wash their hands immediately after use of any chemical substance and before leaving the laboratory. Keep hands and tools (pens and pencils) away from the face and mouth. Storing or consuming food and drinks in the laboratory is prohibited. Mouth pipetting is also prohibited.
- **Injection** - Exposure to chemicals by injection can inadvertently occur through mechanical injury from glass or metal contaminated with chemicals or when chemicals are handled in syringes. Use proper sharps handling practices. Inspect glassware prior to use. Sharps, including razors and cutting blades, should be disposed of in a special sharps container or another glass disposal container. Sharps contaminated with a biohazardous substance must be disposed of in a biosafety sharps container. Broken glass or spilled sharps must be collected using mechanical means (e.g., broom and dustpan) and never with bare hands. To avoid injection injuries to those that pick-up the waste, collect and place the broken glass pieces into a cardboard glass disposal box, and label the box before disposal.

Exposure Assessment and Monitoring

The CHO may be required to perform an exposure assessment of some laboratory work. An exposure assessment takes into consideration any hazardous materials in use, the task being performed and the work environment including engineering controls, administrative controls and PPE. Monitoring may be necessary to assess exposure levels to hazards.

Laboratory workers should contact their manager, PI or the CHO to discuss exposure concerns and request an assessment.

Exposure Limits

Exposure limits have been established to reduce exposure to “acceptable” levels. OSHA sets regulatory exposure limits called permissible exposure limits (PELs). The American Conference of Governmental Industrial Hygienists (ACGIH) has developed recommended exposure limits called Threshold Limit Values (TLVs). The National Institute for Occupational Safety and Health (NIOSH) has developed Recommended Exposure Limits (RELs). Quite often, TLV and REL values are less than OSHA-specified PELs.

Frequency

Initial monitoring will be performed if there is reason to believe exposure levels for a substance

could exceed the action level (see Appendix A: Definitions and Abbreviations) or PEL. Monitoring may be necessary after equipment or process changes, or an unanticipated chemical release.

Periodic monitoring will be performed if the initial monitoring exceeds applicable action levels or PELs. Monitoring frequency will be established by EHSS based on exposure levels (current and previous monitoring) and any additional requirements outlined in applicable standards. Monitoring may be terminated in accordance with the applicable standard.

Records

Laboratory workers will be notified of monitoring results in writing within 15 days of receipt of any laboratory results either individually or by posting in an appropriate location.

The CHO shall maintain records in accordance with the record keeping requirements of applicable OSHA standards.

Medical Surveillance

Idaho State University shall coordinate an offer for medical consultation or examination under the following circumstances:

- A laboratory worker develops signs or symptoms potentially associated with a hazardous chemical that they may have been exposed to in the laboratory;
- Exposure monitoring reveals an exposure level above OSHA permissible exposure limits, ACGIH action levels or where the applicable standard requires such medical surveillance; or
- An event occurs such as a chemical spill, leak or explosion that results in the likelihood of a hazardous exposure.

Reporting Exposure

Laboratory workers who believe they have had an exposure or injury should seek medical attention immediately and contact their PI/supervisor, Risk Management and EHSS.

8.0 Controlling Hazards

Hierarchy of Controls

The control of exposure to chemicals in the laboratory should be accomplished through a hierarchy of controls. In order of preference, the hierarchy of controls begin with hazard elimination, substitution, engineering controls, administrative controls and finally proper personal protective equipment. After hazard elimination/subsitution, engineering and administrative controls are the major control methods for protecting laboratory workers from hazardous materials.

Hazard Substitution and Minimization

Using smaller quantities of hazardous chemicals or substituting a less hazardous chemical reduces the risk of serious exposure or spill. Consider the following possibilities:

- Substitute less hazardous chemicals;
- Work on a smaller scale;
- Order only what is needed; and/or
- Share chemicals when possible

Engineering Controls

Engineering controls eliminate or minimize exposure by removing a hazard or acting as barrier

between a hazard and a worker. Engineering controls are typically more effective at controlling hazards than administrative control practices or personal protective equipment. They often require a higher cost upfront; however, they may be more cost effective in the long run. Engineering controls range in complexity and cost from something as simple as using sharps containers to minimize needle sticks to an interlocking mechanism on an x-ray unit to minimize radiation exposure. In a laboratory, they are often used to minimize contact with a hazard due to chemical splash, explosion or inhalation.

Local exhaust ventilation is an engineering control used to reduce inhalation exposure. Common laboratory examples include:

Glove Boxes: Glove boxes are complete enclosures used to perform work in a separate environment. A different environment may be necessary to control worker exposure or to protect the chemical itself (e.g., an inert atmosphere). Gloves secured to ports allow manipulation inside the unit. Requirements for use are training and SOPs, and depending on the manufacturer's recommendations, sensor calibration and integrity testing of the unit and gloves.

Biosafety Cabinets: Biosafety cabinets (BSCs) are used to control exposure to biological aerosols and protect work materials from contamination using a High Efficiency Particulate Air (HEPA) filter. HEPA filters do not capture chemical vapors. A BSC where the treated exhaust is returned to the laboratory cannot be used for procedures involving flammable liquids or volatile, toxic or odorous chemicals except for small quantities of alcohols used for decontamination. BSCs are inspected annually by an outside vendor.

Extraction Arms (Snorkels): Extraction arms, or snorkels, are typically constructed of flexible ducting and connected to the exhaust ventilation system. They are useful for capturing vapors, fumes and dust at the source of generation. Extraction arms work well when designed properly for a given process with an adequate flow rate. They are typically ineffective for any source beyond the distance of the ducting's radius.

Fume Hoods: The fume hood is the most common method of controlling inhalation exposures to hazardous substances in the laboratory. They are useful against fumes, mists, dusts and vapors. Their use is recommended whenever handling hazardous materials and may be required to reduce exposure to levels below applicable exposure limits. Consideration of the types and quantities of chemicals used will determine the effectiveness of the fume hood.

Some fume hoods are equipped with a low flow alarm. The alarm is an indication the face velocity may be inadequate and not providing proper protection.

Some buildings are equipped with emergency shut-offs for the fume hood exhaust system which differ from the alarm control mentioned previously. The emergency shut-offs are only to be used by Facilities Services or the fire department.

Fume hoods are maintained by EHSS or Radiation Safety and are certified on an annual basis as indicated by a sticker on the fume hood. The sticker is typically found on the side of the sash indicating the height at which the hood was certified. The certification process ensures the fume hood is functioning properly and maintaining a minimum face velocity of 80 feet per minute when measured at the sash threshold.

Any suspected fume hood malfunctions or issues must be reported to the PI and EHSS or Facilities Services. Alterations must be coordinated and approved by EHSS and Facilities. Any repair, relocation or alteration requires recertification of the fume hood by EHSS.

In order for a fume hood to operate properly, adequate airflow is essential. An easy way to accomplish this is by minimizing the number and size of materials in a fume hood. Materials such as large equipment, supplies or chemical containers, cannot be used in a fume hood if it prevents the fume hood from functioning properly. The most common issue stems from blocking the lower baffle, which reduces adequate flow at the sash and can disrupt airflow patterns. It may be possible to elevate the materials to maintain flow to the lower baffle. For large equipment, it is generally more effective to install a specially designed enclosure so the chemical fume hood can be used for the intended purpose.

When working at the chemical fume hood, open the sash only as far as necessary to access the work area. The lowered sash helps contain contaminants in the hood and the smaller hood opening makes the hood less susceptible to room drafts and other external air disturbances. Open sashes can result in an inadequate face velocity and reduce hood effectiveness. The certification sticker indicates the height at which the hood was tested and is the maximum working height for the sash.

When a fume hood is not in use, the sash should be closed. The sash can also help protect against splashes or projectiles from chemical spills or reactions. A lowered sash does not eliminate the necessity for appropriate personal protective equipment.

Additional Safe Work Practices for Fume Hoods

- Work at least six inches behind the sash threshold.
- Never put your head (or face) inside an operating chemical fume hood to check on an experiment.
- Move slowly in and around fume hoods. Be aware that opening/closing doors can disturb the airflow.
- Unless instructed otherwise, fume hoods shall remain on at all times.

Perchloric acid digestions and other procedures performed at elevated temperatures must be conducted in a specifically designed and dedicated fume hood with a wash- down system due to potential formation and build-up of explosive perchloric acid salts. The fume hood cannot be used for any other purpose.

Administrative Controls

Administrative controls consist of policies, programs and procedures which guide work practices to minimize exposure. Programs, such as the CHP, provide guidance on specific topics typically applying to multiple laboratories to guide compliance with regulatory requirements.

Laboratory Hazard Assessment: A laboratory hazard assessment assists PIs and laboratory managers in identifying hazards unique to a specific laboratory.

Standard Operating Procedures (SOPs): Laboratories must establish and maintain standard operating procedures for equipment, processes and procedures performed in the laboratory. An SOP can be used to:

- Communicate to the laboratory worker the potential hazards, required hazard controls and steps to complete a task safely and correctly.
- Satisfy regulatory requirements documenting required safe use of hazardous materials, including required PPE.

- Train laboratory workers in proper procedure and maintain consistency between laboratory workers.

- For the safety and health of personnel, compliance with the OSHA Laboratory Standard, and as determined by the lab hazard assessment, some laboratory operations may require the need to create SOPs specific to the work performed.

Standard Work Practices: Standard work practices apply to the majority of laboratory work or work areas. Information regarding specific chemicals, chemical hazard classes and additional hazards may be obtained from the Chemical Hygiene Officer.

Prepare for Work with Hazardous Chemicals:

- Take the time to read and familiarize yourself with the CHP and all appendices before handling any hazardous chemical.
- Read the university's waste management procedures on the EHS website that contains information covering safe and proper disposal of hazardous chemicals.
- Follow applicable laboratory protocols or SOPs, which outline requirements for handling hazardous chemicals.
- Know the nearest location of all safety equipment as well as evacuation routes and assembly location.
- Become familiar with the health and physical hazards of the chemicals you will be handling.
- For extremely hazardous chemicals or procedures, consider performing a "dry" run with a manager to become familiar with the steps.

Minimize Routine Exposure:

- Activities involving hazardous chemicals should be conducted in a chemical fume hood whenever possible.

- Always mark chemical containers for identification. Do not smell chemicals to determine their identity.

- Change gloves regularly.

- Inspect gloves for tears, cracks, discoloration, and holes before and during use.

- Exhaust of an apparatus that may discharge toxic chemicals should be vented into a chemical fume hood, exhaust ventilation system or filter.

- Storing, handling or consuming food or beverages in laboratories, storage areas, refrigerators, environmental rooms or laboratory glassware is prohibited.

Personal Hygiene

- Long pants and closed-toed shoes are required in chemical laboratories.
- Eating, drinking, smoking, or applying cosmetics in laboratory areas is prohibited.

- Mouth pipetting of any substance is prohibited.

- Hands must always be washed before leaving the laboratory. Solvents must never be used to wash hands.

- Required appropriate PPE (e.g., laboratory coat, eye protection, gloves) must be worn in the laboratory whenever there is a potential for exposure to chemical or physical hazards. Open toed footwear and shorts are prohibited in laboratory work areas.

- PPE must be removed before leaving and not be worn in public areas such as bathrooms, offices, conference rooms, eating areas and outdoors.
- Gloves must not be worn while touching doorknobs, light switches, telephones or other common items unless required by the laboratory-specific safety plan or standard operating procedures.

Housekeeping

- Keeping areas and pathways around emergency equipment, showers, eyewashes and exits clear;
- Keeping areas around all circuit panels clear;
- Keeping all aisles, hallways and stairs clear;
- Keeping all work areas clear of clutter;
- Returning all chemicals to the proper storage area at the end of the day;
- Cleaning up spills promptly; and
- Cleaning benchtops and fume hoods regularly.

Disposal of Chemical Waste

- Manage and store chemical waste in accordance with the Hazardous Waste Management Plan.
- EHSS removes all chemical waste from laboratories.
- Submit a request for disposal of chemical waste through the EHSS website.

Personal Protective Equipment (PPE)

Engineering controls such as chemical fume hoods and glove boxes can be used to control hazards, and further minimize the extent of required PPE. Use of PPE shall only be considered after exercising all other options for reducing hazards. Eliminating unnecessary processes and substances should be the first method used to control hazards.

In addition to engineering controls, PPE is very often utilized to minimize exposure to potential hazards and must be worn when handling hazardous materials or performing potentially hazardous activities in the laboratory. Appropriate PPE is based on the potential hazards and associated risks of the types and quantities of chemicals in use, location of use and how the chemicals are used.

The PI is responsible for determining PPE requirements for each project. The PI must ensure that appropriate types and sizes of PPE are readily available, laboratory workers are properly trained in use and maintenance and laboratory workers comply with PPE requirements. Common laboratory PPE is discussed below. Keep in mind different or additional PPE may be required based upon the hazards and associated risks. See the fact sheet for assistance in choosing appropriate gloves. EHSS can also assist laboratories in the selection of PPE. It should be noted that laboratory hazards and risks can also arise from temperatures, pressures or mechanical actions.

Gloves: Gloves are required when handling hazardous chemicals or for protection from physical hazards such as cuts, extreme temperatures and abrasion. There is no glove currently available that will protect against all chemicals or all types of tasks. Many glove manufacturers have charts available to help determine the most appropriate glove material. Gloves come in a variety of materials, thicknesses and cuff lengths. Selection

must consider the chemicals in use, potential contact time, splash potential and dexterity needs.

It is recommended to change thin disposable gloves once they become contaminated or on a regular interval. In some applications, thicker gloves may be reused, but they must be inspected regularly for nicks, punctures or signs of degradation and discarded when necessary.

Laboratory workers must remove at least one glove before leaving the immediate work site to prevent contamination of public areas (e.g., doorknobs, light switches, telephones, etc.).

Disposable latex gloves are not to be used for chemical protection. Latex has been shown to be a sensitizer to some individuals. Sensitization occurs over time with increased symptoms. Exposure to the latex protein is greatly increased through the use of powdered latex. The use of powdered latex is highly discouraged. If a powdered glove is desired, a powdered nitrile glove is recommended.

Tyvek sleeves/Gauntlet gloves: Tyvek sleeves and gauntlet gloves provide greater forearm protection than a laboratory coat. Uncoated sleeves are fluid resistant and coated sleeves provide increased fluid protection. The sleeves must be worn over a laboratory coat or paired with other necessary body protection. Gauntlet gloves that reach to or extend above the elbow are readily available.

Laboratory Coat: A long-sleeved laboratory coat must be worn whenever infectious, chemical or radioactive hazards exist assuming a similar or more protective level of PPE is not required. A laboratory coat, though not impervious, provides some protection against contact and contamination. Tyvek laboratory coats or coveralls may also be a suitable option and offer added convenience since they are disposable.

Flame retardant lab coats must be used when handling pyrophoric or water reactive compounds (or highly exothermic reactions) and large volumes of flammable liquids, (greater than 4 liters).

Contaminated laboratory coats must be immediately removed and laundered or disposed of properly. Laundering must be done through a commercial laundry service. Home laundering is prohibited. Disposable lab coats are an option. In the case of academic laboratory activities, where smaller volumes, lower concentrations and lower hazard chemicals are used, this requirement may be waived.

Chemical Resistant Apron: Some chemicals or activities may require protection beyond a laboratory coat's capabilities due to splash potential and the hazardous chemical properties. It is important to select an apron compatible with the chemical in use and an appropriate thickness for adequate protection.

Safety Glasses: Safety glasses must be worn when handling hazardous materials or where there is the potential of flying particulate. They must have side shields for added protection. Safety glasses are adequate for handling small quantities of moderately hazardous materials with limited splash potential or materials of low hazard and flying particulate.

Regular prescription glasses have not been determined to meet the Z87.1 requirements. Over-the-glasses (OTG) safety glasses are available and fit over most prescription lenses and frames. A number of retailers offer prescription safety glasses. The frames are marked with Z87 and are fitted with polycarbonate lenses. Side shields are required and typically snap on the bows.

Safety Goggles: Safety goggles must be worn when handling liquid hazardous materials with the potential for splash, volatile hazardous materials and concentrated acids or bases. Goggles fit tightly to the face, minimizing liquid and vapor contacting the eye area. Vented and non-vented models are available. Vented goggles have openings which reduce fogging but increase contact potential. Non-vented goggles have a greater tendency to fog but provide greater protection. An anti-fog coating is an important feature. Most prescription glasses fit under standard safety goggles.

Goggles provide better protection against large amounts of particulates and liquids when compared to safety glasses.

Face Shields: A face shield helps protect the face from splashes and flying particulates. A face shield is only considered supplementary eye protection. Safety glasses or goggles must be worn underneath.

All safety glasses, safety goggles and face shields must meet requirements outlined in American National Standards Institute (ANSI) Z87.1. "Z87" must be imprinted on the equipment indicating it meets proper specifications. If an individual chooses to wear contact lenses in the laboratory, chemical splash goggles must be worn.

Leg and Foot Protection: Close-toed shoes and long pants are required in all chemical use laboratories. Leg protection beyond regular clothing may be required for protection from hazards such as molten metal, heat and cutting hazards. Foot protection, at a minimum, must consist of closed-toed shoes covering the top and sides of the foot. Sandals and open-toed shoes are prohibited. Additional foot protection including steel-toe shoes, leather, or slip-resistant shoes may be required.

Respiratory Protection: Respirator use requires training, medical approval and fit testing as outlined in the Respiratory Protection Plan. Respirators are not to be used in any area without prior approval by EHSS. Contact EHSS for additional information on respirator use.

Additional or different types of PPE may be necessary dependent upon the laboratory and associated activities. Each laboratory shall designate minimum PPE for entry to work areas and include the requirements in the Laboratory Specific Safety Plan.

Contaminated PPE must be decontaminated or properly disposed. Contaminated PPE may require classification as hazardous waste.

9.0 Emergency Response

In any emergency, it is critical that all staff members are familiar with the use and location of all emergency equipment. This includes fire extinguishers, fire alarms, safety showers, eyewash stations, first aid kits and chemical spill kits.

Dial 911 in the event of an emergency. All incidents, accidents and emergency response activities must be reported to your supervisor.

All emergency equipment shall be on a preventive maintenance schedule. Fire alarms are tested periodically, and extinguishers inspected monthly. Laboratories are responsible for activating their eyewashes weekly and recording the checks. Departments are responsible for checking emergency showers monthly and recording checks.

Seeking Medical Treatment

Any person seeking medical attention, but not needing emergency transport or response, should notify their PI and obtain care.

Chemical Exposures

The treatment of a chemical exposure takes precedent over spill cleanup, spill containment or property damage including water damage from the use of an eyewash or safety shower.

If the material is dry or in powder form, brush off all visible contaminant before flushing with water. When possible, obtain assistance to remove contaminated PPE and clothing and contact emergency responders if necessary. If medical attention is sought, provide medical care personnel with copies of all applicable SDSs.

Eye Contact

Eyes must be promptly flushed with water using an eyewash for 15 minutes following contact with any chemical. The eyes should be held open. Medical help should be sought immediately after flushing.

Skin Contact

The affected areas must be immediately flushed with water for 15 minutes. Once the flushing has started, contaminated PPE and clothing must be removed. Medical attention should be sought immediately after flushing.

Inhalation/Ingestion

Move to a clean environment or seek assistance to get away from the contamination and immediately contact emergency responders for guidance (Poison Control Center 1-800-222-1222).

Contaminated Sharps Injury

The affected areas must be immediately flushed with water for 15 minutes. Once the flushing has started, contaminated PPE and clothing must be removed. Medical attention should be sought immediately after flushing.

Chemical Spill

Laboratory personnel can clean up small spills if trained and equipped to do so. Small spills include chemical spills that are up to 1-liter liquids or 0.5 kilograms solids and of limited toxicity and reactivity. Small spills of metallic mercury from broken thermometers (about 1.5 grams) can be cleaned up by laboratory personnel. If respiratory protection is needed for a spill clean-up, the spill is too large to be handled by laboratory personnel – dial 911 or call EHS at 208-282-2310 during normal business hours. See Appendix C for additional spill clean-up procedures.

10.0 Chemical Storage

Segregation

Materials should always be segregated and stored according to their chemical family or hazard classifications. Do not store chemicals alphabetically unless they are compatible.

The most common hazard classes include:

- Flammables/combustibles
- Corrosive acids
- Corrosive bases/ caustics
- Toxic
- Highly toxic
- Oxidizers
- Compressed gases
- Cryogens
- Pyrophoric
- Water reactive
- Explosives

Accidental contact between incompatible chemicals can result in a reaction causing fire, explosions, the formation of highly toxic and/or flammable substances or other potentially harmful situations.

Each chemical family should be separated from all other chemical families. Ideally, each hazard class would be kept in a cabinet or on a shelf segregated from other hazard classes. Incompatible chemicals within the same hazard class should be separated from one another. Chemical storage guidelines are available on the EHSS website.

Most laboratories have limited space. The following priorities may help you decide how to store chemicals.

- Limit the amount of chemicals on hand to just what is needed to complete work.
- Do not store chemicals alphabetically unless they are compatible.
- Store flammable liquids in approved safety containers in flammable storage cabinets. Do not store anything but flammable or combustible liquids in these cabinets.
- Segregate acids from bases.
- Segregate most organic acids from oxidizing mineral acids.
- Keep oxidizers away from other chemicals, especially flammables, combustibles and toxic materials.
- Keep corrosives away from substances that may react with and release corrosive, toxic or flammable vapors.

Basic Storage Requirements

The following basic storage requirements apply to all hazardous chemicals. Refer to Appendix C for more detailed information on chemical storage procedures.

Storage Area Requirements:

- Label storage areas according to the type of chemical family or hazard classification.
- Inspect storage areas annually or at the end of projects.
- Keep storage areas well-lit and appropriately ventilated.
- Eliminate ignition sources such as open flames, heat sources, or direct sunlight.
- Confine chemical storage areas so that leaks or spills are controlled. Prevent chemicals from running into sinks or floor drains.
- Clean up spills and drips immediately.
- Do not store chemicals in sinks or fume hoods.
- Chemicals may not be stored on the floor or window ledges.

Storage Cabinets: Use only UL-approved storage cabinets. Never alter a flammable storage cabinet unless directed to do so by EHSS. Storage cabinets shall be labeled with the hazard class of the chemicals.

Storage Shelves: Shelves should be level, stable and secured to the wall or other stable surface. Shelves should have stable raised edges or lips to prevent containers from falling. Containers should not protrude over edges. Storage of materials must not be above eye level. Shelves should be kept free of chemical contamination and dust and be located away from direct sun, flame, or heat sources.

Storage Containers: Keep containers closed unless you are dispensing a chemical or adding to the container. Never store a container open or with a funnel in it. Provide secondary containment for liquids in containers larger than 1 gallon in size. Use approved containers for flammable solvents.

Chemical Stability

Stability refers to the susceptibility of the chemical to undergo dangerous decomposition. Ethers and olefins form peroxides on exposure to air and light. Since these chemicals are packaged in an air atmosphere, peroxides can form even though the containers have not been opened. Write the date received and date opened on all containers of peroxide forming chemicals.

Compressed Gases

- Carefully read the label before using or storing compressed gas. The SDS will provide any special hazard information. Always use the minimum size cylinder required to perform the work.
- All cylinders of compressed gases must be handled as high energy sources. When storing or moving a cylinder, secure the cap in place to protect the stem. Use suitable racks, straps, chains or stands to support cylinders. Compressed gas cylinders pose a crush hazard to hands and feet.
- Do not expose cylinders to temperature extremes.
- Do not store cylinders or lecture bottles with the regulator in place. If the regulator fails, the entire contents of the gas cylinder may be discharged.
- Always use the correct regulator. Do not use a regulator adapter. Oil or grease on the high-pressure side of an oxygen cylinder can cause an explosion. Do not lubricate an oxygen regulator.
- A cylinder should never be emptied to a pressure lower than 172 kPa (25 psi) because the residual contents may become contaminated with air if the valve is left open.
- Always wear safety glasses when handling compressed gases.
- The various hazard classes must be segregated and stored in quantities dictated by International Fire Code (IFC). Contact EHSS for assistance with compliance. This citation applies to all chemical storage in buildings.

Expired Chemicals

Any expired or out-of-date chemical must be properly disposed if it presents an increased safety risk over time such as peroxide formers and picric acid.

Time-Sensitive Expired Chemical Disposal: Failure to dispose of time sensitive chemicals prior to their expiration date can result in unnecessary risk, disposal difficulty and increased cost. Depending on the chemical and its age, testing and disposal by an outside vendor may be required. In extreme cases, an explosive ordinance disposal unit (i.e., bomb squad) may be required.

11.0 Laboratory Closeouts

Researchers are required to follow proper procedures prior to vacating any laboratory or other space where chemical, biological or radioactive materials have been used or stored. Events requiring decommissioning of a laboratory include:

- Terminating affiliation with the Idaho State University;
- Relocating to another laboratory space;
- Major laboratory renovation; and
- Retirement from research activities.

12.0 Appendices

Appendix A: References

1. Furr, A.K., Ed, CRC Handbook of Laboratory, 4th ed., CRC Press: Boca Raton, FL., 1995

2. Mahn, W. J. Fundamentals of laboratory safety: physical hazards in the academic laboratory, Van Nostrand Reinhold, New York, 1991

3. Mahn, W. J. Fundamentals of laboratory safety: physical hazards in the academic laboratory, Van Nostrand Reinhold, New York, 1999

4. OSHA Safety and Health Standards (29CFR1910) - United States Department of Labor, OSHA, Government Printing Office: Washington, DC., (latest edition)

5. Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, National Research Council, National Academy Press: Washington, D.C., 2011

6. Safety in Academic Chemistry Laboratories- 3rd ed., Committee on Chemical Safety, American Chemical Society: Washington, D.C., 2003

7. UC Center for Laboratory Safety, University of California at Los Angeles, Los Angeles California, 2012, from cls.ucla.edu.

8. University of Illinois, Chicago, Environmental Health and Safety, Laboratory Compliance Documents, 2019

9. Walters, C.C., Ed., Safe Handling of Chemical Carcinogens, Mutagens, Teratogens, and Highly Toxic Substances, Ann Arbor Science Publishers, Inc., Ann Arbor, MI., 1980, Vol. I

Appendix B: Definitions and Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists

Acute Toxicity	Chemicals having high acute toxicity are those that have oral, inhalation, or dermal LD50 and LC50 values below specified thresholds listed in the OSHA Hazard Communication Standard. These values are as follows: • Oral LD50 (albino rats) < 50 mg/kg • Dermal LD50 (albino rabbits) < 200 mg/kg • Inhalation LC50 (albino rats) < 200 ppm in air
Asphyxiants	An asphyxiant is a chemical (gas or vapor) that can cause death or unconsciousness by suffocation. Simple asphyxiants such as nitrogen, either use up or displace oxygen in the air. They become especially dangerous in confined or enclosed spaces. Chemical asphyxiants, such as carbon monoxide and hydrogen sulfide, interfere with the body's ability to absorb or transport oxygen to the tissues.
Carcinogens	Carcinogens cause cancer through irreversible, uncontrolled growth of cells in an organ or tissue. It is believed that there is no known minimum dose that can remove all danger of cancer. Benzene is a known carcinogen. Select carcinogens are substances that meet one of the following criteria: • It is regulated by OSHA as a carcinogen; • It is listed under the category, "Known to be Human Carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); • It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or • It is listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria: o 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; o After repeated skin application of less than 300 (mg/kg of body weight) per week; or o After oral dosages of less than 50 mg/kg of body weight per day.

Corrosives	Corrosives cause rapid death of the body cells contacted. Exposure may cause pain, burning, bleeding and fluid loss. Corrosives include acids and bases. Due to the nature of bases and some acids, pain response may not be immediate upon exposure.
Department Chemical Hygiene contact	Individual designated by Department Chair to serve as liaison with the ISU Chemical Hygiene Officer to implement the Chemical Hygiene Plan
Health Effects	• **Acute health effects** happen immediately after a chemical exposure. Effects are generally apparent and can often be easily traced to the exposure. Acute reactions are normally short-lived and may be followed by recovery, although occasionally permanent damage occurs**.** • **Chronic health effects** are not always obvious and onset of symptoms is gradual. It is much harder to trace the cause of a chronic effect, since the exposure could have been 20 – 30 years prior to the appearance of the effect.
LC50 (Lethal Concentration)	The concentration that kills 50% of test animals within a specified time.
LD50 (Lethal Dose)	The dose required to produce death in 50% of the exposed population within a specified time.
Occupational Safety and Health Administration (OSHA)	OSHA is part of the federal government and provides regulations and assistance for workplace health and safety.
Particularly Hazardous Substances (PHSs)	PHSs are chemicals defined by OSHA to be select carcinogens, reproductive toxins and chemicals having high acute toxicity. Laboratories using PHSs must prepare and implement laboratory-customized standard operating procedures for these substances.

Permissible Exposure Limit (PEL)	PELs are OSHA and DBS regulatory limits for inhalation which may consist of: • **Time Weighted Average, 8 hour (TWA8)** – Average concentration over an 8-hour period. • **Short Term Exposure Limit (STEL)** – Average concentration over a 15-minute interval. • **Ceiling (C)** – Maximum concentration at any given time. • **Action Level (AL)** – concentration designated in 29 CFR part 1910 for a specific substance, calculated as an 8-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance. Exceeding any of these levels for a chemical requires additional actions to be taken which may include additional monitoring, engineering controls, administrative controls or PPE.
Personal Protective Equipment (PPE)	PPE is worn for protection against exposure to chemicals, projectiles, or other hazards. Examples include safety glasses, safety goggles, gloves, and laboratory coat.
Reproductive Toxins	Reproductive toxins are chemicals that may adversely affect male and female reproductive health and the developing fetus. Information about chemical reproductive toxins is available through the OSHA web site and on the State of California's Proposition 65 list, which is updated annually. Always consult the Safety Data Sheet for a chemical to determine if it could be a reproductive toxin prior to use.
Threshold Limit Value (TLV)	A time-weighted average concentration under which most people can work consistently for 8 hours a day, day after day, with no harmful effects. A table of these values and accompanying precautions is published annually by the ACGIH.

Appendix C: Spill Response

Safe chemical handling requires routine inspections of chemical storage areas and maintenance of stringent inventory control. The inherent hazards of chemicals can be reduced by minimizing the quantity of chemicals on hand. When chemicals must be used, proper storage and handling can reduce or eliminate associated risks. All chemical storage areas and cabinets should be inspected regularly. Any unwanted or expired chemicals should be removed from inventory and a pathway for disposal should be identified. All hazardous waste must be disposed of through the Environmental Health and Safety Department.

Typical storage considerations include temperature, ignition control, ventilation, segregation and identification. Proper segregation is necessary to prevent incompatible materials from inadvertently coming into contact. A physical barrier and/or maintaining distance between materials is effective for proper segregation. Proper storage information can usually be obtained from the Safety Data Sheet

(SDS), label, or other chemical reference material. An SDS must be available for review for every hazardous chemical in the workplace.

Keys for Safe Chemical Storage:

- Ensure all containers of hazardous chemicals are properly labeled with the identity of the hazardous chemical(s) and appropriate hazard warnings.
- Do not purchase compounds in quantities greater than can be used in the specified storage time period.
- Segregate incompatible chemicals for proper storage of chemicals by hazard class. In other words, store like chemicals together and away from other groups of chemicals that might cause reactions if mixed.
- Do not store chemicals alphabetically except within a grouping of compatible chemicals.
- Flammable materials should be stored in an approved, dedicated flammable materials storage cabinet or storage room if the volume exceeds ten gallons. Keep cabinet doors closed. See this page for much more information and grounding requirements. (http://ehso.com/OSHA/firesafety/flammableliquids.php)
- Chemicals should be stored no higher than eye level and never on the top shelf of a storage unit. Do not overcrowd shelves. Each shelf should have an anti-roll lip.
- Avoid storing chemicals on the floor (even temporarily) or extending into traffic aisles.
- Liquids should be stored in unbreakable or double-contained packaging, or the storage cabinet should have the capacity to hold the contents if the container breaks.
- Store acids in a dedicated acid cabinet. Ideally, nitric acid should be stored in its own acid cabinet. If not possible, it may be stored with other acids, but only if it is kept isolated from all other acids, with secondary containment.
- Store highly toxic or controlled materials in a locked, dedicated poison cabinet.
- Volatile or highly odorous chemicals shall be stored in a ventilated cabinet. Chemical fume hoods shall not be used for storage as containers block proper airflow in the hood and reduce available workspace.
- All chemicals should be labeled and dated upon receipt in the lab and upon opening. This is especially important for peroxide-forming chemicals such as ethers, dioxane, isopropanol, and tetrahydrofuran. Solutions should be labeled and dated. (See Table 2 for suggested time limits for peroxide containing chemicals.)
- Ethers should be stored in the dark and under nitrogen if possible.
- Always check for the presence of peroxides before distilling any peroxide-former.
- If old containers of peroxide-forming chemicals are found, do not move them. Contact the Environmental Health and Safety Department for assistance in disposing of the container.
- Look for and correct adverse conditions in chemical storage areas, such as:
    - Improper storage of chemicals
    - Leaking or deteriorating containers
    - Spilled chemicals
    - Temperature extremes (too hot or cold in storage area)
    - Lack of or low lighting levels
    - Blocked exits or aisles
    - Doors blocked open/unlocked, lack of security

- Trash accumulation
- Open lights or matches
- Fire equipment blocked, broken, or missing
- Lack of information or warning signs ("Flammable liquids", "Acids", "Corrosives", "Poisons", etc.)

- First aid supplies, emergency phone numbers, eyewash and emergency shower equipment, fire extinguishers, spill cleanup supplies, and personal protective equipment should be readily available and personnel trained in their use. Do not block access to these items.
- Chemicals stored in explosion-proof refrigerators or cold rooms shall be sealed and labeled with the name of the person who stored the material in addition to all other required hazard warnings.
- Only compressed gas cylinders that are in use and secured in place shall be kept in the laboratory. All others, including empties, shall be sent to the compressed gas cylinder storage area for the particular facility.
- Keep all stored chemicals, especially flammable liquids, away from heat and direct sunlight.\

Table 1: Basic Chemical Segregation

Hazard Class of Chemical	Recommended Storage Method	Examples	Incompatibilities
Compressed gases - Flammable	Store in a cool, dry area, away from oxidizing gases. Securely strap or chain cylinders to a wall or bench.	• Methane • Hydrogen Acetylene Propane	Oxidizing and toxic compressed gases, oxidizing solids.
Compressed gases - Oxidizing	Store in a cool, dry area, away from flammable gases and liquids. Securely strap or chain cylinders to a wall or bench.	• Oxygen • Chlorine • Bromine	Flammable gases
Compressed gases - Poisonous	Store in a cool, dry area, away from flammable gases and liquids. Securely strap or chain cylinders to a wall or bench.	• Carbon monoxide • Hydrogen sulfide • Nitrogen dioxide	Flammable and/or oxidizing gases.
Corrosives - Acids	Store separately in acid storage cabinet. Segregate oxidizing acids (i.e., Chromic, nitric, sulfuric, and perchloric acids) from organic acids	• Acetic acid Phenol • Sulfuric acid Chromerge • Nitric acid * • Perchloric acid • Chromic acid • Hydrochloric acid	Flammable liquids, flammable solids, bases, oxidizers
Corrosives - Bases	Store in separate corrosive storage cabinet. Store solutions of inorganic hydroxides in labeled polyethylene containers.	• Ammonium hydroxide • Sodium hydroxide • Calcium hydroxide	Flammable liquids, oxidizers, poisons, and acids

Flammable Liquids	Store in flammable storage cabinet and away from sources of ignition. Store highly volatile flammable liquids in an explosion-proof refrigerator.	• Acetone Benzene • Diethyl Ether Methanol • Ethanol Toluene • Glacial Acetic acid	Acids, bases, oxidizers, and poisons
Flammable Solids	Store in a separate dry, cool area away from oxidizers, corrosives, flammable liquids	• Phosphorus, yellow • Calcium Carbide • Picric acid • Benzoyl Peroxide	Acids, bases, oxidizers, and poisons
General Chemicals - Non-reactive	Store on general laboratory benches or shelving preferably behind glass doors and below eye level.	• Agar • Sodium chloride • Sodium bicarbonate • Most non-reactive salts	See specific SDS.
Oxidizers	Store in a spill tray inside a chemical storage cabinet. Separate from flammable and combustible materials.	• Ammonium Persulfate • Ferric Chloride • Iodine • Sodium Hypochlorite • Benzoyl Peroxide • Potassium Permanganate • Potassium Dichromate • The following are generally considered oxidizing substances: peroxides, perchlorates, chlorates, nitrates, bromates, superoxides.	Reducing agents, flammables, and combustibles.
Poisons/Toxic Compounds	Store separately in vented, cool, dry area, in unbreakable chemical-resistant secondary containers and in accordance with the hazardous nature of the chemical.	• Aniline • Carbon Tetrachloride • Chloroform • Cyanides • Oxalic acid • Phenol • Formic acid • Heavy metals compounds, i.e., cadmium, mercury, osmium	Flammable liquids, acids, bases, and oxidizers. See specific SDS.
Water-Reactive Chemicals	Store in dry, cool location, protect from water fire sprinkler.	• Sodium metal • Potassium metal • Lithium metal • Lithium aluminum hydride	Aqueous solutions and oxidizers.

Carcinogens	Label all containers as "Cancer Suspect Agents." Store according to the hazardous nature of the chemical, using appropriate security when necessary.	• Benzidine • Beta-naphthylamine • Benzene • Methylene chloride • Beta-propiolactone	See specific SDS.
Teratogens	Label all containers as "Suspect Reproductive Hazard". Store according to the hazardous nature of the chemical, using appropriate security when necessary.	• Lead and mercury compounds • Benzene • Aniline	See specific SDS.
Peroxide-Forming Chemicals	Store in airtight containers in a dark, cool, dry area. See Table 2 for recommended storage time limits.	• Diethyl ether • Acetaldehyde • Acrylonitrile	See specific SDS.
Strong Reducing Agents	Store in cool, dry, well-ventilated location. Water reactive. Segregate from all other chemicals.	• Acetyl chloride • Thionyl chloride • Maleic anhydride • Ferrous sulfide	See specific SDS.

*Nitric Acid-Ideally, nitric acid should be stored in its own acid cabinet. If not possible, it may be stored with other acids, but only if it is kept isolated from all other acids, with secondary containment.

Table 2: Storage of Peroxidizable Compounds

Peroxide-forming materials are items that can react with molecular oxygen over time under normal conditions of use and storage to form peroxides. Peroxides formed in this way can be potentially shock sensitive and explosive, particularly when dry. Many different materials are capable of peroxide formation, and certain molecular structures are known to exhibit this behavior. Known materials are typically categorized in lists by the hazard level and type of the peroxide formed. All peroxide forming materials must be dated when opened. **Date opened must be readily visible on container**.

Category A **chemicals form explosive levels of peroxides without concentration.** **Examples of Category A chemicals are listed below:**	
Butadiene (liquid monomer)	Potassium metal
Chlorprene (liquid monomer)	Potassium amide
Divinyl ether	Sodium amide

Divinyl acetylene	Tetrafluoroethylene (liquid monomer)
Isopropyl ether	Vinylidene chloride

Category B **chemicals are known to form dangerous peroxides at potentially hazardous levels when the material is used or stored in such a way that the peroxides could increase in concentration. Many common laboratory solvents are category B chemicals.** **Examples of Category B chemicals are listed below.**	
Acetaldehyde	1,4-Dioxane
Benzyl alcohol	Decalin
Cyclohexanol	Tetrahydrofuran (THF)
Cumene	Tetralin
Diethyl ether	

Category C **chemicals are highly reactive and can auto-polymerize as a result of internal peroxide accumulation. The peroxides formed in these reactions are extremely shock- and heat-sensitive.** **Examples of Category C chemicals are listed below.**	
Acrylic acid	Styrene
Acrylonitrile	Tetrafluoroethylene
1,3-Butadiene	Vinyl acetate
2-Butanol	Vinyl acetylene
Chloroprene	Vinyl chloride
Chlorotrifluoroethylene	Vinyl pyridine
Methyl methacrylate	

1. **All peroxide forming chemicals must be labeled when received and when opened.**

2. **All peroxide forming chemicals must be tested for peroxide formation every 3 months, after opening.**

3. **Peroxide testing must be dated and initialed on the container and logged in the Laboratory Specific Safety Plan.**

If testing indicates any presence of peroxide formers, contact EHS and submit a hazardous waste pick-up request through the EHS website. Include the level of prodoxids (as indicted by the test strip) in communications with EHS.

Any individual, including PIs or ALMs desiring to stabilize peroxides levels in a container with peroxide forming chemicals, must submit an SOP addressing potential risk and hazards to the Chemical Hygiene Officer for approval.

Do not open or move bottle if crystals, discoloration or layering are present. EHS must be contacted for disposal if prodoxid testing is positive, or if crystals, discoloration or layering can be seen.

Appendix D: Laboratory Specific Safety Plan – Template

Appendix E: Laboratory Self-Inspection

Appendix E-
Laboratory Inspectic