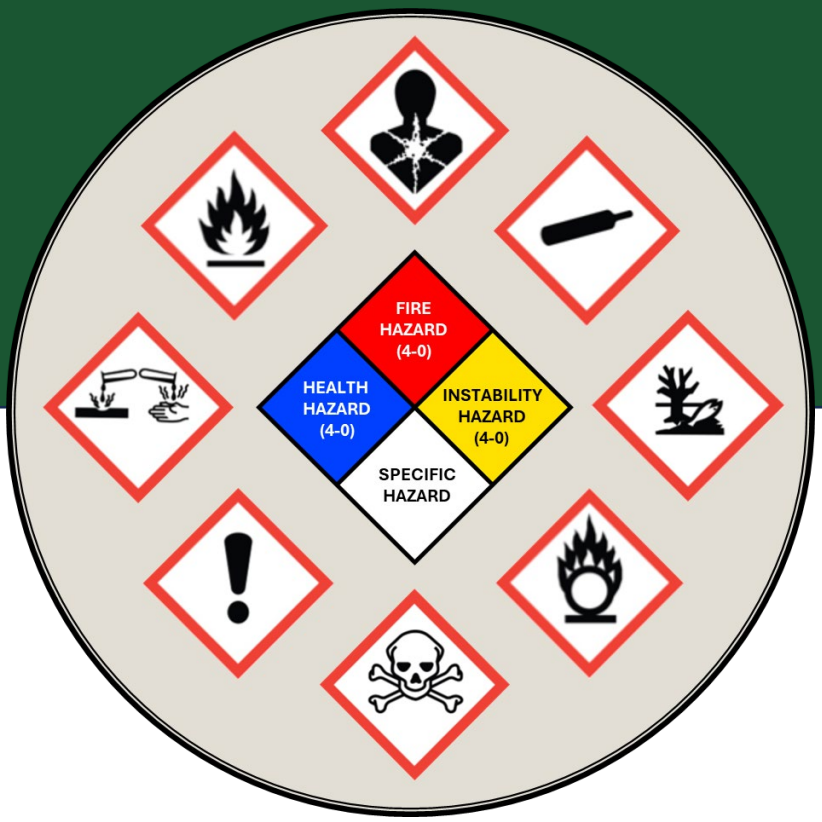


CHEMICAL & LABORATORY SAFETY MANUAL

ENVIRONMENTAL HEALTH AND SAFETY

UAB
THE UNIVERSITY OF ALABAMA AT BIRMINGHAM

CHAPTER 1: INTRODUCTION

The purpose of the Chemical Laboratory Safety Manual is to outline policies and procedures specific to the handling of chemicals and hazardous materials at the University of Alabama at Birmingham (referred to as UAB hereafter). It will serve as a foundational resource, recognizing that individual laboratories may have unique safety considerations that are not necessarily covered. The policies and procedures outlined herein are considered the standard practice for chemical safety and environmental health and have been adopted as official University Policy.

These policies and procedures apply universally to anyone involved in procuring, acquiring, possessing, using, or disposing of hazardous chemical materials at UAB. All laboratory personnel should read this manual and use it for reference. In addition, all laboratory personnel must complete chemical safety training before commencing work with chemicals. Training records for each person must be maintained by (the PI or laboratory manager).

Safe work practices are expected from all UAB personnel and students, with a shared responsibility for upholding safety policies in their respective areas and ensuring compliance with these regulations by others. These regulations are not designed to impede the quality, quantity, or academic freedom associated with research or teaching. They are not meant to be rigid but are open to necessary exemptions and flexibility for the advancement of scientific pursuits.

All laboratory personnel are encouraged to report safety concerns to their supervisors, laboratory safety representative or departmental safety committees. If additional support is required, the UAB Department of Environmental Health and Safety (EH&S) is available for assistance, investigation, and recommendations for necessary actions at ChemicalSafety@uab.edu or 205-934-2487.

CHAPTER 2: SCOPE

The regulations and procedures set forth in the Laboratory and Chemical Safety Manual are intended to provide guidelines and best practices for the handling of potentially hazardous materials. The manual applies to all operations at UAB where students, faculty, staff and visitors may be exposed to hazardous materials under normal working conditions and duties or during an emergency event. It is the purpose of this manual to provide guidance in establishing safe work practices for the procurement, acquisition, possession, use, storage and proper disposal of hazardous materials on the campus of UAB.

2.1 Definitions

For the purposes of this manual, the following definitions apply:

Chemical Hygiene Officer (CHO) – The CHO is an employee who is designated by Environmental Health and Safety (EH&S) who is qualified by training or experience to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan (CHP).

Chemical Laboratory Safety Manual (CLSM) – A manual to provide guidance in establishing safe work practices for the use of chemicals and hazardous materials.

Chemical Safety and Environmental Management Committee (CSEMC) – The CSEMC is a committee of faculty and technical staff that serve as a resource to develop and maintain policies and procedures applicable to physical and health hazards of chemicals used in laboratories.

Hazardous Material – A hazardous material is any item or agent (whether chemical, biological, radiological, and/or physical) that can cause a physical or health hazard.

Institutional Biosafety Committee (IBC) – The IBC is a committee of faculty and technical staff that reviews, approves and oversees research projects that involve (but are not limited to) recombinant DNA, RNAi, pathogens, bacterial toxins, human materials and other potentially infectious materials.

Lab Safety & Chemical Hygiene Plan (LS/CHP) – The Chemical Hygiene Plan is a written program developed and implemented by EH&S that sets forth procedures, work practices, necessary equipment, control measures, and personal protective equipment requirements to protect student, faculty, staff and visitors from the safety risks and potential health hazards presented by hazardous materials used on the campus of UAB.

Lab Worker – Any person who handles chemicals/materials and/or unwanted material in a laboratory and may include but is not limited to faculty, staff, post-doctoral fellows, interns, staff researchers, technicians, supervisors/managers and principal investigators.

Principal Investigator (PI) – A PI is the individual responsible for the preparation, conduct and administration of a research lab. This person holds the full responsibility to direct and oversee a research study.

Safety Data Sheet (SDS) – An SDS is a detailed informational document prepared by the manufacturer or importer of a chemical.

Standard Operating Procedure (SOP) – A set of written instructions that describes the step-by-step process of an experiment or procedure to be repeated by persons in the laboratory.

2.2 Policy Statement

The University of Alabama at Birmingham (UAB) is committed to protecting the safety and wellbeing of its students, faculty, staff and visitors. UAB is also committed to complying with all applicable legal, regulatory and policy requirements associated with environmental health and safety (EH&S) in its facilities and operations. This commitment is demonstrated through the establishment and implementation of a Laboratory Safety & Chemical Hygiene Plan (LS/CHP) for procurement, use, storage and disposal of hazardous chemicals on campus. UAB does and will continue comply with all applicable OSHA workplace safety and health requirements and will maintain safety and health standards that equal or exceed the best practices of environmental health and safety.

2.3 Noncompliance

Violations of federal, state and local regulations can lead to criminal and civil penalties for individuals and the institution. Confirmed violations of this policy or any associated Chemical Safety Plan elements are subject to commensurate consequences, up to and including termination, dismissal, or severance of other relationships with UAB.

2.4 Implementation

The Senior Vice President for Finance, through the Department of Environmental Health and Safety (EH&S), is responsible for administering the institutional Chemical Safety Plan. The CHO is a member of the EH&S staff and, with support from Facilities and EH&S, has the overall responsibility for ensuring the implementation of all components of the LS/CHP and conducting its annual review.

The Vice President for Research is responsible for appointing a Chemical Safety and Environmental Management Committee to serve as a resource for review of the CHP, address chemical and environmental safety issues and review research protocols involving highly hazardous chemicals.

CHAPTER 3: RELATED RESOURCES

3.1 Chemical Laboratory Safety Manual

3.2 UAB Policy on Use of Controlled Substances

3.3 CHP Compliance Resources

6 CFR Part 27, Chemical Facility Anti-Terrorism Standards (CFATS)

49 CFR and relevant provisions within, Hazardous Material Transportation Act

27 CFR, working with explosives and energetic materials

29 CFR 1910 and relevant provisions within, Laboratory Standard, Hazard Communication Standard, PPE Standard, Protection against hazards of compressed gases, flammable and combustible liquids, explosives

ADEM Environmental Management Code 335 and relevant provisions within

CHAPTER 4: RESPONSIBILITIES

4.1 The Department of Environmental Health and Safety (EH&S)

EH&S is dedicated to supporting UAB and its mission of conducting research, education and clinical care in a safe and healthy environment. Each distinct area listed is responsible for different aspects of the overall health and safety culture that is fostered here at UAB. As such, each area listed here has specific areas of interest and responsibility that ultimately blend to create an environment in which faculty, staff, students and visitors will know that their health, safety and well-being is of the utmost importance to us here at UAB.

- EH&S is responsible for providing regulatory communication and program support to maintain compliance with federal, state and local agencies at UAB. This includes developing policies, recommendations, and guidelines.
- EH&S is responsible for developing and providing training programs designed to meet federal, state and local regulatory requirements.
- EH&S helps ensure that investigators, staff, students and visitors comply with all federal, state and local regulatory standards and codes.
- EH&S provides leadership for UAB's health and safety programs.
- EH&S establishes, monitors and enforces institutional health and safety policies and procedures.
- EH&S provides education and guidance on environmental health and safety issues, including but not limited to work practices and activities involving hazardous and regulated materials, equipment and environments.
- EH&S serves as consultants in providing health and safety information to laboratory personnel at UAB.
- EH&S has the overall responsibility to develop and maintain the chemical laboratory safety manual (CLSM) and implement policies and programs outlined accordingly.
- EH&S serves as a liaison between the University and the regulatory agencies enforcing environmental, health and safety regulations.
- EH&S provides the campus institutional chemical hygiene officer responsibilities.
- EH&S provides resources and support to implement lab safety programs, including but not limited to the lab safety review program.

4.2 Chemical Hygiene Officer (CHO)

As part of EH&S, the chemical hygiene officer (CHO) works to support and provide guidance for the University's research programs where all chemicals and potentially hazardous materials are concerned including but not limited to the Chemical Laboratory Safety Manual (CLSM), the chemical hygiene and laboratory safety plan and other lab and research safety manuals, protocols and policies. The CHO will work with EH&S to develop plans, programs, training and policies in accordance with federal, state and local regulatory requirements and agencies. The CHO:

- Is primarily responsible for ensuring the implementation of the Chemical Laboratory Safety Manual and CHP in all areas on the campus of UAB and works in conjunction with facilities and EH&S.

- Performs day-to-day implementation of a health and safety program for faculty, staff, students and visitors working with hazardous materials in the workplace in compliance with federal, state and local regulations governing their management, use and disposal.
- Is responsible for development and periodic updating of the UAB CLSM and LS/CHP in accordance with UAB policy and consistent with governmental regulatory standards.
- Advises the UAB research community of its responsibilities with respect to chemical safety, laboratory health and safety issues.
- Recommends appropriate corrective actions/programs and implements new health and safety programs.
- Monitors procurement, use and disposal of chemicals.
- Develops programs and writes procedures to ensure safe work practices and compliance with applicable regulatory agencies governing chemical procurement, management, storage, use and disposal.
- Manages and provides EH&S training programs including but not limited to chemical hygiene, emergency response and incident prevention, hazard communication, proper storage and disposal of hazardous materials.
- Serves on the committees that review research protocols involving the use of hazardous materials, physical agents or novel techniques with the potential to result in an employee exposure or health risk.
- Performs safety walkthroughs, risk assessments and behavioral-based safety observations and makes recommendations for safe-work practices and advises corrective actions for laboratory incidents.
- Consults and/or assists the UAB spill response team on chemical spills and provides response training when needed.
- Investigates accidents/incidents involving hazardous materials to determine the root cause and possible violation of safety guidelines or breach of containment and provides corrective actions accordingly.
- Investigates violations of safety guidelines within the laboratories and implements appropriate corrective actions in consultation with administration and the CSEMC.
- Will be made aware of plans for renovations or new laboratory construction projects and will serve as a resource in providing regulatory standards and codes to assist with the design and construction process where potentially hazardous materials are concerned.
- With concurrence of the Executive Director of EH&S may stop any work involving the use of hazardous materials that creates an indisputable risk or danger to personnel or involves experiments prohibited by the University. The Executive Director will present findings to the CSEMC who will review the issue along with the CHO and forward a written recommendation to the Vice President of Research Administration for final action.

4.3 Chemical Safety and Environmental Management Committee (CSEMC)

The Vice President of Research is responsible for appointing a Chemical Safety and Environmental Management Committee (CSEMC) to serve as a resource to develop, recommend, update and maintain policies and procedures applicable to physical and health hazards of chemicals. The CSEMC meets bimonthly and is responsible for the following:

- Is to be composed of faculty and technical staff who provide consultation, technical assistance and recommendations to EH&S relating to hazardous substances in laboratories.
- Reviews and approves projects and protocols using hazardous chemicals/materials.
- Reviews and recommends appropriate programs for compliance with existing and new regulations involving the use of hazardous chemicals/materials.
- Recommends suitable, safer chemical/material substitutes as deemed appropriate.
- Reviews and recommends improvements regarding the Chemical Safety Program.
- Reviews and makes recommendations regarding the safe disposal of hazardous chemicals/materials.

4.4 Department Chairpersons/Directors

The department chairperson or director of each department (or research center or institute) is responsible for the general safety of faculty, staff, students and visitors working in the overall area of jurisdiction. This responsibility is *not* reduced by activities of the IBC, the RSC, the CSEMC or EH&S. The department chair shall ensure that each PI in their area or jurisdiction is provided with access to the UAB chemical safety manual and CHP and should ensure compliance with the guidelines therein. They are responsible for:

- If needed, appoint a departmental safety representative/coordinator who will implement policies within the CLSM to ensure compliance with the Laboratory Safety Program and serve as a contact with EH&S.
- Informing EH&S of work involving hazardous materials and reporting incidents involving hazardous materials.
- Ensuring faculty members who supervise teaching laboratories are educating students of proper precautions to be taken when working with hazardous materials.
- Ensuring that employees are properly trained on the potential hazards of the materials they use in their work area and trained in the proper use of equipment needed to safely handle these materials.
- Determining and ensuring that safety needs and equipment for units are met (e.g., engineering controls, training, and PPE) and ensuring corrective actions for noncompliance identified in safety audits are promptly corrected.
- Ensuring that research projects within their department/center are registered with EH&S through project registration.
- Ensuring that new arrivals or departures of PIs/researchers are reported to EH&S immediately when the information is made available.
- Ensuring procedures are in place for reporting accidents and incidents affecting laboratory operations within your department, and ensure corrective actions are taken, as necessary, to prevent incident recurrence.
- Ensure all UAB laboratory policies are followed in accordance with local, state and federal regulations.

4.5 Principal Investigator/Faculty/Lab Supervisors

The Principal Investigator (PI) will act in accordance with the policies and procedures as directed by their department and the leadership of that department. They will also comply and work with EH&S on matters relating to safe laboratory practices and handling of hazardous materials. The PI is responsible for:

- Appointing a "lab delegate" in their laboratory who will ensure all laboratory staff understand that new and changed procedures must be assessed for hazards.
    - The lab delegate must be familiar with the laboratory's procedures and determine controls to adequately minimize risks of each laboratory procedure.
- Ensuring that all persons involved in using hazardous materials are thoroughly trained in methods to minimize exposure and understand the potential health risks associated with their use.
- Ensuring all lab personnel. Including volunteers, are registered with UAB Occupational Medicine.
- Ensuring that training for each person in the lab is documented and kept on file.
- Ensure visiting scientists performing procedures within the laboratory have equivalent training as other employees on the hazards and safety precautions, including PPE requirements.
- Complying with the UAB CLSM and the Laboratory Safety and Chemical Hygiene Plan and all applicable regulations.
- Conducting hazard evaluations for procedures conducted in the laboratory and maintain a file of standard operating procedures documenting those hazards.
- Establishing emergency procedures to be followed if there is a spill or accident involving chemicals/hazardous materials.
- Reporting any unusual incident, such as a spill or release of a hazardous material, to EH&S and the department chairperson or program director, whichever is appropriate.
- Completing an accident/incident report form in the event of an injury or suspected injury.
- Procuring all hazardous materials used in the laboratory following the existing university guidelines.
- Procuring emergency equipment and personal protective equipment needed to safely use, store and handle the materials.
- Ensuring the security and accountability of all regulated materials such as controlled substances (Schedules I-V), particularly hazardous chemicals such as peroxide formers, pyrophoric materials, tax free alcohol and other chemicals requiring inventory control.
- Ensuring that the online chemical inventory is updated in a timely manner (minimum annually).
- Cooperate with EH&S during laboratory audits and ensure actions identified in safety audits are completed in a timely manner.
- Ensure that all appropriate engineering controls including chemical fume hoods and safety equipment are available, certified annually and in good working order in their laboratories.
- Notifying EH&S when significant changes in chemical use may require a re-evaluation of the laboratory ventilation.
- Notifying EH&S about potential lab closure or relocation, with at least two months' notice.
- Enforcing restrictions on children and minors in the laboratory.
- Performing annual reviews and updates of the Laboratory Safety and Chemical Hygiene Plan with the Chemical Hygiene Officer.

4.6 Departmental Safety Representative/Coordinator

The departmental safety representative/coordinator will liaise with EH&S to help their department share information about changes to overall department policies as well as those that impact UAB as a whole. The representative will aid in communications and preparations for any department-wide training programs or other safety related activities. The departmental safety representative will:

- Work with EH&S to coordinate the implementation of the policies and programs outlined in the CSWMM and the CHP.
- Assist department chairs, directors, unit heads, supervisors and individuals within the areas they represent to establish departmental, unit or facility-wide safety programs, priorities, objective and targets for safety, health and environmental performance.
- Establish a department or unit-wide safety committee.
- Work with EH&S to stay abreast of the university health and safety policies and procedures that apply to and occur within the areas they represent.
- Develop, coordinate and implement a departmental emergency response plan and communicate the plan to EH&S.
- Promote EH&S programs within the department by disseminating information and by distributing EH&S safety shorts, fliers, etc.
- Encourage departmental staff to report all incidents and/or injuries and near misses to EH&S.
- To facilitate proper laboratory decommissioning, notify EH&S no less than two (2) months before a faculty member retires, leaves the university or relocates laboratory.
- Notify EH&S before a new faculty member joins that department to facilitate proper laboratory setup/remodeling.

4.7 Laboratory Manager

Under the direction of the principal investigator, the laboratory manager is responsible for ensuring compliance with the laboratory safety program within the laboratory. The manager functions as a liaison with EH&S and the laboratory. They may appoint a *designee* to conduct the routine duties outlined below, such as a graduate student or lab worker. The laboratory manager is responsible for:

- Maintaining the chemical inventory in EHSA, and ensuring it is updated at least annually via EHSA.
- Maintaining a current SDS inventory, accessible to everyone in the laboratory.
- Conducting and maintaining accurate training records.
- Ensure laboratories are compliant with all university policies and federal, state and local regulations.

4.8 Employees/Students

Laboratory employees are personnel who conduct their work in a laboratory and are at risk of possible exposure to hazardous chemicals on a regular or periodic basis. These personnel include laboratory technicians, instructors, researchers, visiting researchers, administrative assistants, graduate assistants, student aides, student employees and part time and temporary employees. Employees are responsible for:

- Compliance with the CLSM and LS/CHP and all other health and safety practices by keeping class, work and laboratory areas safe and free from hazards.

- Practicing safe procedures in the workplace as outlined in the CLSM and LS/CHP.
- Notifying their supervisor of any unsafe conditions or practices observed.
- Knowing the location of the LS/CHP and how to access SDS.
- Attending training as required by EH&S and their supervisor.
- Conducting and maintaining hazard evaluations of all laboratory standard operating procedures (SOPs) with their supervisor.
- Familiarizing themselves with the emergency evacuation plan, emergency response plan and the location of any emergency equipment.
- Compliance with laboratory audit requests from EH&S.
- Following all PPE requirements and guidelines at all times.
- Following the SOPs for their laboratory and incorporating the guidelines and requirements outlined in the CLSM into their everyday practice.

4.9 Visitors, Volunteers and Minors

To have visitors, volunteers or minors in the laboratory, the PI must follow UAB guidelines described in the policy, Minors and Volunteers in UAB Research Laboratories.

Before starting work, shadowing, observing, visitors, minors and volunteers must complete all required training. For guidance on required training, refer to https://www.uab.edu/ehs/training or contact EH&S at **205-934-2487 or** ChemicalSafety@uab.edu **for further assistance.**

CHAPTER 5: EMERGENCY MANAGEMENT

5.1 Emergency Response

The UAB Emergency Management has prepared several real-world scenario response plans for individuals who are on campus at the time of an emergency. https://www.uab.edu/emergency/response

UAB has response plans for active shooter, building evacuation, chemical spills, contagious diseases, explosions, power outage, hazardous materials incidents, medical emergencies, natural gas leaks, tornados as well as many others. You can review the plans any time.

https://www.uab.edu/emergency/responseplans

These response plans are useful in developing laboratory-specific plans so that in an emergency, everyone is informed and prepared.

5.2 Emergency Procedure for Laboratories

Many of the response plans may be useful for laboratory and general campus emergency situations. General plans such as tornado response, active shooter, power outage etc. can be useful, regardless of your current location on campus. Other plans are more specific to a laboratory setting and may be useful when an emergency occurs in the laboratory. Response plans such as chemical spill, building evacuation, hazardous material incidents, and many others are useful when working in the laboratory. In any event, the response plans are available online. These response plans can help you develop laboratory-specific response plans so that your laboratory personnel are prepared for any situation. You can also use the guidelines provided below.

https://www.uab.edu/emergency/responseplans

5.3 Emergencies

In an emergency

1. **Contact UAB Police by dialing 911 from any UAB campus phone** or **205-934-3535** from a cell phone.
2. Contact the EH&S Emergency On-Call at **205-917-4766**.
3. If emergency involves **a radiation source/radioactive material**: contact UAB paging at **205-934-3411** and ask for Health Physicist on call at pager #**7746**.
4. For first-aid, decontamination and emergency procedures, refer to **Emergency Procedures.**
5. For information of where to seek medical help, refer to the **On-the-Job Injury & Illness**

5.4 Emergency Planning

Incidents can happen without warning and being prepared is the essence of any emergency plan. As such, the University expects each department/division/laboratory to develop its own detailed emergency plan

(**Laboratory Safety Plan**). The plan should be known to all persons in the department and a written plan should be kept on file.

5.5 Fire Safety Plans and Emergency Evacuation Plans

Every laboratory must have a safety plan and an emergency evacuation plan. A guide for developing specific emergency plans can be found at **Emergency Preparedness Response Guide**. EH&S is available for consultation if assistance is needed in developing a department-specific emergency evacuation plan. Departments may also be contacted by EH&S to ensure that emergency evacuation plans are being discussed, planned and implemented, and that drills are being scheduled as needed.

5.6 Laboratory Fire and Explosion

Fires are the most common types of laboratory incidents. Everyone in the lab must be aware of the locations of:

- The fire alarm pull station
- Fire Extinguishers
- Emergency Safety shower
- Eye Wash Stations
- Telephone
- Emergency contact phone numbers
- Evacuation route

5.7 Major Fire/Explosion

In the event of a fire or explosion that cannot be safely extinguished with a fire extinguisher or by smothering the fire by the laboratory personnel:

- Evacuate the area.
- Alert others in the vicinity/building by activating the fire alarm system at the nearest fire pull station (always know the locations in your immediate area of the building).
- Dial 911 and report the exact location of the fire or explosion.
    - **911 from campus phone OR 205-934-3535 from a cell phone to reach UAB police. 911 from cell phone will get Birmingham Police.**
- Evacuate and stay clear of the building by following the lab emergency evacuation plan.
- When emergency response personnel arrive inform them of:
    - The exact location: building name and room number.
    - Type of hazardous material involved/present in the lab.
    - Your name and contact information.

5.8 Small Laboratory Fires

If safe to do so, respond to a small fire as follows:

- Use fire extinguishers only if trained to operate it and can do so safely.

    - Position yourself between the fire and the exit door to avoid being trapped.
- Extinguish fires in smalls vessels by covering the vessel loosely.
- **NEVER** pick up chemical bottle/vessel of burning material.
- Notify coworkers and call for help if needed.
- In the event of a more serious fire, evacuate the laboratory and activate the nearest fire alarm.
    - When emergency personnel arrive, inform them of the type of hazardous materials present in the laboratory.
- If a person's clothes are on fire, place them under the safety shower and immediately turn on the shower.
    - If the shower is not accessible, wrap the person with a lab coat, blanket or whatever is available to extinguish the fire.
    - Roll the person on the floor if necessary to extinguish the fire.
    - Remove any clothing contaminated with chemicals/hazardous materials.
    - Douse with water to remove any remaining heat.
    - Wrap the injured person to shock and exposure.
    - Get medical attention.
- Never touch a person in contact with a live electrical circuit.
    - Disconnect the power first pr you also may be seriously injured.
- For a small electrical fire, use a regular (ABC) fire extinguisher.

Report all fires, even small fires to your supervisor and EH&S at **205-934-2487** when safe to do so.

5.9 Fire Extinguishers

Each laboratory is equipped with an (ABC) class fire extinguisher. These extinguishers are general use and appropriate for most fires. Laboratories that use materials that require specialized fire extinguishers are supplied to them for those specific materials only. Only use a fire extinguisher to fight a fire if you have been trained and feel safe doing so.

UAB offers fire extinguisher training online for classification and use of fire extinguishers. Individual departments can schedule hands-on instruction for their personnel. Campus safety will bring all the necessary equipment and fire extinguishers to the department to give everyone the opportunity to have hands-on training with a real fire and how to extinguish it safely.

If there are any questions, concerning fire extinguishers, fire safety or any other emergency response related issues or concerns, please reach out to Campus Safety.

The link for the online fire extinguisher course is listed below.

https://www.uab.edu/ehs/campus-safety/fire-extinguisher-use

5.10 Non-fire Emergencies

Each laboratory should develop a non-fire emergency plan. Employees must be trained on the contents of the plan and how to respond in a non-fire emergency. These plans are available and just need to be adapted to fit the specific needs of the laboratory.

Non-fire emergencies include:

- Loss of electricity, water (basic utilities), etc.
- Failure of HVAC systems.
- Weather related events (tornado, flood, etc.)
- Campus shooting or violence event.
- Hazardous material release in nearby lab.
- Hazardous material release outside of buildings or laboratory (i.e. car accident causing gas release onto the street).

5.11 Procedures for Power Outage

5.11.1 Laboratory Procedures

Electrical power can fail at any time as part of an isolated incident or a larger event caused by a natural disaster. Planning prepares you for an emergency, and the emergency plan for any laboratory should include a defined list of procedures in the event of an emergency.

5.11.2 Emergency Plan

Each laboratory should have an emergency plan for power outages and the plan should include at least:

- Have designated emergency contact persons (two individuals), familiar with the lab and have sufficient knowledge of the chemicals and processes performed in the laboratory and accessible 24/7.
- Have emergency light source such as flashlights in the lab and inform all personnel of the location and operation of that light source.
- Have procedures for safely stopping or controlling hazardous procedures during a power failure.
- Identify the location of emergency/dedicated power outlets and ensure they are never overloaded with extension cords.
- Have a list of essential equipment that requires emergency power supply.
    - Equipment including but not limited to laboratory refrigerators and freezers (both -20 °C and -80 °C freezers).
- Program equipment that operates unattended to shut down safely during power failure and not restart automatically when power is restored, if possible.
- Have a list of equipment that must be reset or restarted once power returns. Keep instructions for doing so at or near the equipment.
- Equip fume hoods with nonelectrical indicators to show they are operating (ex: a strip of paper that shows there is still air flow).

5.11.3 While the power is out

- Turn off and unplug all non-essential electrical equipment, if possible to do so safely, to reduce risk of power surges that could result when the power is restored.
- Close all open containers of solvents to prevent potential reactions/explosions due to volatile chemical vapors accumulating in the room in the absence of a functioning ventilation system.
- Stop all work inside the fume hoods and close the sashes.
- Secure all experimental work according to the emergency plan. Make sure that experiments are stable and do not create uncontrolled hazards.
- Shut down experiments that involve hazardous material or equipment which automatically restarts when power is restored.
- Turn off all gas cylinders and valves. Any exceptions should be part of a written, pre-approved SOP where it is vital for the material or process.
- Ensure all refrigerator and freezer doors are closed and avoid opening them to maintain temperature for a few hours.
- Identify an emergency source of dry ice if you have items that must be kept cold in the event the power is out for more than a few hours. Never use dry ice in cold rooms, walk-in refrigerators or other confined areas as the carbon dioxide can cause asphyxiation.
- Move out of darkened areas as directed.
- If you have experimental animals in the lab during the time of an outage, follow the plans developed for your department with respect to animal care during outages, giving the utmost care and caution for the protection of personnel as well as the animals.

5.11.4 When Power is Restored

- Check the lab for any usual or strange odors. If an odor or something dangerous is detected, call **911** from a campus phone OR **205-934-3535** from a cell phone to reach UAB police.
- Immediately evacuate the lab and alert the contact person if there are any strange odors or spills.
- Reset/restart/check equipment as necessary.
- Check all fume hoods for airflow and keep the sash down for at least 10 minutes to remove any vapors accumulated in the hood.

5.11.5 For Assistance

Contact EH&S (ChemicalSafety@uab.edu) if you need assistance in developing a personalized lab emergency plan.

5.12 Laboratory Emergency Shut Down Procedures

Each laboratory must develop an emergency shut down plan for their lab and train employees to implement the plan in case of an emergency. Necessary steps involved in this plan depend on the nature of the work performed in each laboratory. EH&S can assist labs to develop a plan specific to their work and needs. Below are some steps to consider when developing lab-specific plans.

- Close all fume hood sashes.
- Close all chemical bottles and store appropriately.
- Turn off all non-essential electrical devices.

- Make sure all essential equipment is plugged in to the dedicated emergency power outlets.
- Turn off all gas cylinders at the tank/regulator.
    - If any inert gas cylinders need to remain attached to special equipment, pre-approval is necessary and should be part of the emergency response plan.
- Leave refrigerators and freezers on and ensure doors remain closed.
- Shut off vacuum pumps and any other evaporation devices used in the lab.
- Check all cryogenic vacuum traps (Nitrogen, Carbon Dioxide, and solvent) as the evaporation of trapped material may cause dangerous conditions.
- Check all cylinders or tanks with cryogenic liquids to ensure they are vented to prevent the buildup of internal pressure.
- Turning off heating and distillation devices.
- Terminate all reactions that are in progress, based on the known scope of the emergency.
- If experimental animals are in use, special precautions may need to be taken to secure those areas that include emergency power and alternative ventilation, etc.
- All non-essential staff/students must evacuate the building.
- It is important to remember that some equipment does not shut down automatically (such as large cryogenic magnets, sources of radioactivity, etc.) and as such requires a plan for the duration of the outage as well as when the power is restored.
- Be sure to check any special operating procedures for all equipment before an emergency occurs.

5.13 Medical Emergency

- Call 911 from a campus phone or 205-934-3535 from a cell phone to reach campus police, fire or medical response to preserve a life.
- Tell the dispatcher who answers the phone:
    - Current location: street address, building name and room number.
    - Type of injury/exposure or emergency.
    - Your name and contact phone number.
- Remove the victim to a safe place if needed and ONLY if it is safe to do so; DO NOT move the victim unnecessarily.
- Provide first aid if you have the appropriate training and equipment and it is safe to do so.

For details refer to **On-the-Job Injury & Illness**

5.14 First Aid Kit

All laboratories are required to have a first aid kit readily available for all personnel, per OSHA CFR 1910.266 App A. The location of the kit must be known to anyone working or visiting the lab in case of an emergency. The PI or lab manager must ensure that supplies meet the standard listed. Kits should be checked regularly to replace supplies that have been depleted or are out of date.

- Kits should include:
    - Gauze pads (at least 4x4 inches)

  - Two large gauze pads (at least 8x10 inches)
  - Box of adhesive bandages (band-aids)
  - One package gauze roller bandage (at least 2 inches wide)
  - Two triangular bandages
  - Wound cleaning agent such as sealed moistened towelettes
  - Scissors
  - At least one blanket
  - Tweezers
  - Adhesive tape
  - Medical/exam gloves
  - Resuscitation equipment such as resuscitation bag, airway or pocket mask.
  - Two elastic wraps
  - Splint
  - Directions for requesting emergency assistance.
- Any incident where a first aid kit is used must be reported through **On-the-Job Injury & Illness**.
- You must also report injuries to your supervisor immediately.

5.15 Emergency Response for Chemical Spills

EH&S can provide assistance in assembling spill kits for laboratories. EH&S also offers a hands-on training course on "how to do a spill clean-up" upon request. For information on spill kits and training, call or email EH&S at 205-934-2487; ChemicalSafety@uab.edu.

- For **large spills** (**Spill Decision Tree**)**:** call EH&S emergency on-call at **205-917-4766** or UAB police at **911** from any campus phone or **205-934-3535** from a cell phone.
- For **small spills** refer to **Emergency Response Spill Kit.**

5.16 Mercury Spills

Mercury was once commonly used throughout the University in many technical laboratory and diagnostic procedures. When contained properly, mercury is of little threat to human health. Immediate attention to a mercury spill is important as it can accumulate over time resulting exposure to mercury vapor. For mercury spill response guidelines, please refer to the **Mercury Spill Response**.

5.17 Spill Response Plan

It is very important to develop a spill prevention plan. Spills can be handled more effectively when a plan of action has been developed. Spill procedures should include the following:

- Potential location(s) of a spill.
- Estimated quantities of chemical/material that might be release in the event of a spill.
- Chemical and physical properties of the material including associated hazards.
  - Consult SDS and/or container label(s)
- Hazardous properties of the material.
  - Consult SDS

- Personal protective equipment (PPE) needed for spill response and cleanup.
- Location and contents of spill kits.
- Items required in spill kit.

5.18 Injury/Illness Reporting

Any injury/illness/suspected exposure must be reported by completing the OJI form(below) and send any cases of non-life-threatening injury/suspected injury to The Workplace (2151 Highland Ave. Birmingham AL 35205. **On-the-Job Injury & Illness**

If there is a needle stick or chemical exposure, UAB's employee health website provides a decision tree (lab exposures) to determine if immediate medical attention is warranted. If there is an injury in the lab, UAB's employee health website provides a decision tree to determine if medical attention is warranted (lab injury decision tree).

Injuries appearing to present immediate danger to life or limb should be transported to the University Hospital Emergency Department by calling **911** from any campus phone or **205-934-3535** from a cell phone.

5.19 Emergency Procedures and Injuries

To learn how to respond to laboratory emergencies, refer to **Emergency Procedures.**

- If exposed to:
  - **Eye Contact**: promptly flush eyes with water for 15 minutes and seek medical attention
  - **Ingestion**: get medical attention immediately. Never attempt to give anything by mouth to an unconscious person.
  - **Skin Contact**: promptly flush the affected area with water for 15 minutes and remove any contaminated clothing. Soap may be necessary for non-water-soluble compounds. If symptoms persist after washing, seek medical attention.
  - **Inhalation**: move the victim to fresh air. If the victim is unconscious or not breathing, seek emergency medical attention immediately by calling 911. Attempt to identify the substance(s) involved (to aid emergency responders).
  - **Clothing on fire**: if a person's clothes are on fire, immediately utilize the safety shower to extinguish flames and cool the skin quickly. Removed any clothing contaminated with chemicals. If a shower is not available, immediately wrap the victim in a fire-safe blanket or anything available to extinguish the fire. If necessary, employ "drop and roll" to extinguish the fire. Wrap the person in a blanket to avoid shock and exposure. Seek immediate medical attention.
  - **Live electrical circuit**: ***do not*** touch a person on contact with a live electrical circuit. Disconnect the power first or you may be seriously injured.

5.20 Medical Consultations

Medical surveillance or consultation will be coordinated by the employee health program (UAB Employee Health). All laboratory personnel are required to register with the employee health program. Others may register if desired or in the following situations:

- If an employee develops signs and symptoms associated with a hazardous chemical to which he/she has been exposed.
- If environmental monitoring reveals exposure levels consistently above the action level for an OSHA regulated substance with medical surveillance requirements.
- If an event takes place such as a spill, leak, direct skin contact or other occurrence, that results in the likelihood of over-exposure.
- Medical surveillance may also be needed if an employee regularly works with hazardous drugs, materials or chemicals identified by the CSEMC as extremely hazardous. The UAB Employee Health program should be contacted to determine if medical surveillance or consultation is warranted.

All required medical examinations and consultations should be provided to the laboratory personnel at no cost, without loss of pay and at a reasonable time and place.

The physician or other licensed healthcare professional shall keep written records or all such medical examinations and must maintain these records for the duration of the employee's employment plus 30 years. Employees shall have access to their medical records in accordance with OSHA standard CFR 1910.1020.

The opportunity to receive medical attention, including any follow up examinations will be provided to employees who work with hazardous chemicals under the following circumstances:

- Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed during their regular work hours in the laboratory.
- Where airborne exposure monitoring reveals an exposure level routinely above the Permissible Exposure Limit (PEL) for an OSHA regulated substance.
- Whenever an event such as a spill, leak explosion or other occurrence takes place and results in the likelihood of a hazardous exposure. Upon such an event, the affected employee shall be provided an opportunity for medical consultation. The consultation shall be for the purpose of determining the need for a medical examination.

Refer to OSHA guidelines for OSHA Permission Exposure Limits.

CHAPTER 6: CHEMICAL SPILLS and EMERGENCIES

Follow the guidelines outlined in the approved chemical specific SOP. General guidelines can be obtained at **Emergency Procedures** and **Emergency Response Spill Kit**.

Contact EH&S at 205-934-2487 (ChemicalSafety@uab.edu) for more assistance.

6.1 Exposure

Follow the steps below for any exposures.

1. Provide First Aid Immediately
    - Sharps injury (needle sticks and subcutaneous exposure)
        - Scrub exposed area thoroughly for fifteen (15) minutes using warm water and soap.
        - Refer to the Needle Sticks & Exposures for further guidance on any further action.
    - Skin exposure
        - Use the nearest sink for fifteen (15) minutes.
            - For localized exposure
        - Use the nearest emergency shower for fifteen (15) minutes.
            - Gross or large area exposure
            - Remove clothing and any other contaminated material in contact with body (shirt, shoes, etc.)
    - Use a clean lab coat or clean scrubs to cover person if available.
    - Eye Exposure
        - Use emergency eye wash for fifteen (15) minutes while holding eyelids open.
    - Inhalation
        - Move to an area physically separated from the contaminated space where fresh (or at least clean) air is available.
2. Get Help

    - Refer to the following information for on-the-job injuries; found on the UAB employee health page - Resources
    - Notify supervisor and lab PI as soon as possible.
    - Secure area before leaving.
    - Follow any guidance in the chemical-specific SOP exposure control plans.
    - Follow guidance from laboratory chemical hygiene plan regarding exposures and/or emergencies.

3. Reporting
    - If accident is serious and requires hospitalization, call 911 from any campus phone or 205-934-3535 from a mobile phone and go to UAB Emergency Department (ED) after providing first aid and/or getting help.

- All incidents should be reported to Human Resources by following instructions on the UAB employee health page - Resources
- After acute response/reporting requirements are addressed, report the incident to EH&S at 205-934-2487 or ChemicalSafety@uab.edu.

6.2 Inactivation and Disposal

Some hazardous chemicals need to be inactivated before disposal.

- Inactivate any waste that needs inactivation before disposal (refer to chemical specific SOP).
- Place any used PPE, disposables or spill cleanup debris in a hazardous waste plastic bag for disposal.
- For mixed waste contact EH&S support facility for disposal instructions.
    - Chemical waste mixed with radioactive waste.
- For hazardous waste disposal, registration of the PI in EHSA is required. Manifests are available within the EHSA system and are linked to the chemical inventory of the laboratory (EHSA).
- For questions or assistance, please contact EH&S at 205-934-2487 or ChemicalSafety@uab.edu.

CHAPTER 7: MINIMIZING CHEMICAL EXPOSURES and MONITORING

Working safely with hazardous materials includes minimizing exposure, proper training, understanding the hazards, proper labeling, proper storage, proper transport and safe disposal. Laboratory personnel should conduct their work under conditions that minimize the risks from both known and unknown hazardous substances. Before beginning any laboratory work, the hazards and risks associated with an experiment or activity should be determined (through a risk assessment) and necessary precautions implemented. Every laboratory should develop facility-specific policies and procedures for the highest-risk materials and procedures used in their laboratory.

7.1 Two Types of Chemical Hazards

Chemicals pose two types of hazards: health hazards and physical hazards.

7.1.1 Physical Hazard

A physical hazard, as defined by OSHA, is a chemical for which there is scientifically valid evidence that it is a:

- Combustible liquid
- Compressed gas
- Explosive
- Flammable
- Organic peroxide
- Oxidizer
- Pyrophoric
- Reactive
- Water reactive
- Unstable

7.1.2 Health Hazard

A health hazard, as defined by OSHA, is a chemical for which there is statistically significant evidence that acute or chronic health effects may occur in exposed employees. "Health hazards" includes chemicals that are:

- Carcinogens
    - A few examples of commonly used chemicals:
        - Arsenic
        - Benzene
        - Beryllium
        - Cadmium
        - Formaldehyde
- Toxic
    - A few examples of commonly used chemicals:
        - Chlorine
        - Bromine

        - Cyanide (any type)
        - Phosgene
        - Mercury
- Highly toxic agents
    - A few examples of commonly used chemicals:
        - Neurotoxins
        - Biological agents
        - Ricin
- Reproductive toxins
    - A few examples of commonly used chemicals:
        - Acetaldehyde
        - Aluminum Chloride
        - Benzene
        - Chloroform
        - β-Mercaptoethanol
- Irritants
    - A few examples of commonly used chemicals:
        - Methylene Chloride
        - Sodium Dodecyl Sulfate
        - Formaldehyde
        - β-Mercaptoethanol
        - Alcohols
- Corrosives
    - A few examples of commonly used chemicals:
        - Hydroxides
        - Imidazole
        - Sulfuric Acid
        - Hydrogen Peroxide
        - Amines
- Sensitizers
    - A few examples of commonly used chemicals:
        - Diazomethane
        - Isocyantes
        - Halides (benzylic or allylic)
        - Phenols
        - Formaldehyde
- Hepatotoxins
    - A few examples of commonly used chemicals:
        - Carbon Tetrachloride
        - Vinyl Chloride
        - Paraquat
        - Polychlorinated Biphenyls
        - Transition metals
- Nephrotoxins

    - A few examples of commonly used chemicals:
        - Some antibacterials
        - Cisplatin
        - Cyclosporins
        - Lactams
        - Aminoglycosides
- Neurotoxins
    - A few examples of commonly used chemicals:
        - Lead
        - Glutamate
        - Nitric oxide
        - Botulinum toxin
        - Tetanus toxin
        - Tetrodotoxin
- Agents that act on hematopoietic system
    - A few examples of commonly used chemicals:
        - Benzene
        - Dithiocarbamines
        - Ethylene Oxide
        - Heavy metals (such as Mercury, Cadmium, Chromium, Cobalt, Lead, Aluminum)
- Agents that damage organs such as
    - Lungs
        - Nitrogen dioxide
        - Sulfur Dioxide
        - Formaldehyde
    - Skin
        - Acids
        - Bases
        - Sodium Dodecyl Sulfate
        - Phthalates
    - Eyes
        - Strong acids
        - Bases
        - Any irritants
        - Any corrosives
    - Mucous membranes
        - Proteases
        - Irritants
        - Antibacterials

7.2 Resources on Chemical Hazards

There are many materials used in the workplace can be hazardous. However, in order for them to be a health hazard, they must come into contact with the body or be absorbed by the body. More information on the different types of hazards can be found below.

List of Highly Hazardous Chemicals
Chemical Hazards and Toxic Substances – Overview
Chemical Hazards and Toxic Substances – Controlling Exposures
Ensuring the safe handling of chemicals

7.3 Globally Harmonized System (GHS) Pictograms

To ensure chemical safety in the workplace, information about the identity and hazards of the chemicals must be available and understandable to all laboratory personnel. Globally harmonized system of classification and labeling of chemicals (GHS) provides a common and coherent approach to classifying chemicals and communicating hazard information on labels and safety data sheets.

7.4 Pictograms

Under the global harmonization system, the Hazard Communication Standard (HCS) requires pictograms on labels to alert users of the chemical hazards to which they may be exposed. Each pictogram consists of a symbol on a white background framed with a red border and represents a distinct hazard(s). The pictogram on the label is determined by the chemical hazard classification.

The quick cards and the brief explaining the labels and pictograms are found below.

7.5 Routes of Entry – How Chemicals Get Into the Body

To understand how chemical hazards can affect a person, it is important to first understand how chemicals enter the body. The four main routes of entry:

- Inhalation
- Ingestion
- Injection
- Absorption through the skin and eyes

7.5.1 Inhalation

As a person breathes, what is in the air is inhaled. If dust, particles and chemicals are in the air, they may be deposited into the lungs or cross into the bloodstream along with oxygen. Inhaled dusts and fibers caught in the nose and airway are on an “escalator” made of hair-like cilia and mucus and then swallowed. Inhalation is the major route by which toxic substances enter the body.

7.5.2 Ingestion

Chemicals can enter the stomach either by eating or drinking contaminated food or drink or by swallowing contaminated mucus that has been expelled from the lungs.

Food and drink are most frequently contaminated by contact by:

- Unwashed hands
- Gloves
- Clothing
- Left exposed/uncovered
- Storing or consuming in a laboratory

Nail biting and smoking can also contribute to ingestion of chemicals.

7.5.3 Injection

Injection is the third way chemicals may enter the body. While uncommon in most workplaces, it can occur when a sharp object (e.g., a needle) punctures the skin and injects a chemical (or biological agent) directly into the bloodstream. Little is known about the toxicity of chemicals that enter through injection (or needle sticks), it is no less important to note that chemical exposures can occur through injection.

7.5.4 Skin Absorption

The skin may present two major routes of exposure. Many chemicals cross through the skin and get into the bloodstream (DMSO, solvents and insecticides). Other chemicals (e.g. nitric acid) corrode the skin causing burns and blisters. Chemicals pass through the skin into the blood. If the skin is irritated, damaged or punctured, absorption is increased. Human skin, in different areas of the body absorbs chemicals at different rates. Chemicals most easily penetrate areas of the body such as the forearms, which may be particularly hairy, since they can enter down the small duct containing the hair shaft. In addition, eyes and mucous membranes are areas that chemicals are easily penetrated or absorbed.

7.6 Exposure vs. Toxicity

Exposure is how chemicals enter the body. Toxicity is amount of the chemical that becomes lethal. The toxicity of a chemical refers to its ability to damage an organ system (ex: kidneys, liver), disrupt a biochemical process or disturb an enzyme system at some site remote from the site of contact. The toxicity of materials is assessed by their Lethal Dose at 50% (LD_{50}) or Lethal Concentration at 50% (LC_{50}). LD_{50} is the oral dose at which 50% of the exposed test animals died, usually within 1-2 hours. LC_{50} is concentration in air at which 50% of the test animals died, usually within 1-2 hours.

The potential health effects of exposure to chemicals depend on several factors:

- Properties of the chemical
    - Including toxicity
- Dose of the chemical
- Concentration of the chemical
- Route of exposure

- Duration of exposure
- Individual susceptibility
- Chemical synergism or antagonism

7.7 Permissible Exposure Limits (PELs)

A PEL is the maximum amount of a chemical substance that a worker may be exposed to under OSHA regulations. PEL is usually given as a Time Weighted Average (TWA). A TWA is an average over a specified period, usually a nominal eight hours, which is a typical work shift time frame. A short-term exposure level is the acceptable average exposure over a brief period of time (usually fifteen (15) minutes of the time-weighted average is not exceeded). OSHA has assigned PELs for many highly hazardous chemicals.

7.8 Acute vs. Chronic Exposure

The dose-time dependent relationship forms the basis for distinguishing between acute and chronic toxicity. The acute toxicity of a chemical in most cases, refers to its ability to inflict systemic damage from a one-time exposure to relatively large amounts of the chemical. In most cases, the exposure is sudden and results in an emergency. A worker exposed to acute doses of toxic chemicals can cause them to lose consciousness and even die. The names, abbreviations, CAS# and PELs can be found in **Table 7.1.**

TABLE 7.1 CHEMICAL NAME	CHEMICAL FORMULA	CAS #	NIOSH IDLH (PPM)	OSHA PEL/NIOSH REL		NFPA RATING	LC50 (PPM)
ARSENIC PENTAFLUORIDE	AsF_5	7784-36-3	5	NIOSH REL TWA 0.001 ppm	4		-
ARSINE	AsH_3	7784-42-1	3	NIOSH REL TWA 0.002 mg/L; OSHA PEL 0.05 ppm	4		120
BIS(TRIFLUOROMETHYL)PEROXIDE	$C_2F_6O_2$	927-84-4	10	-	-		-
BORON TRIBROMIDE	BBr_3	10294-33-4	50	NIOSH REL 1 ppm	3		-
BORON TRICHLORIDE	BCl_3	10294-34-5	25	-	4		2541
BORON TRIFLUORIDE	BF_3	7637-07-2	25	OSHA Ceiling Limit - 1 ppm	4		436
BROMINE	Br_2	7726-95-6	3	OSHA PEL 0.1 ppm	3		174
BROMINE CHLORIDE	BrCl	13863-41-7	-	-	3		-
BROMOMETHANE	CH_3Br	74-83-9	250	NIOSH REL 20 ppm	3		302
CARBON MONOXIDE	CO	630-08-0	1200	NIOSH REL 35 ppm	3		4600/5000
CHLORINE	Cl_2	7782-50-5	10	-	3		433(10 min), 250 (30 min)
CHLORINE PENTAFLUORIDE	ClF_5	13637-63-3	-	-	-		194
CHLORINE TRIFLUORIDE	ClF_3	7790-91-2	12	-	4		95
CHLOROPICRIN	CCl_3NO_2	76-06-2	2	-	4		9.7
CYANOGEN	C_2N_2	460-19-5	-	-	4		-
CYANOGEN CHLORIDE	CNCl	506-77-4	-	-	4		-
DIAZOMETHANE	CH_2N_2	334-88-3	2	-	4		175
DIBORANE	B_2H_6	19287-45-7	15	-	4		40
DICHLOROACETYLENE	C_2Cl_2	7572-29-4	-	NIOSH REL 0.1 ppm	-		-
DICHLOROSILANE	H_2Cl_2Si	4109-96-0	-	NIOSH REL 0.1 ppm	4		1785-2092
DIMETHLYMERCURY	HgC_2H_6	593-74-8	-	-	4		-
ETHYLENE OXIDE (ANHYDROUS)	C_2H_4O	75-21-8	800	-	3		90 mg/L
FLUORINE	F_2	7782-41-4	-	-	4		20 ppb
FORMALDEHYDE	CH_2O	50-00-0	20	NIOSH REL 0.016 ppm	3		333
GERMANE	GeH_4	7782-65-2	-	NIOSH REL 0.2 ppm	4		440
HYDROGEN AZIDE	HN_3	7782-79-8	-	NIOSH REL 0.1 ppm	4		-

HYDROGEN CYANIDE	HCN	74-90-8	50	-	4	503
HYDROGEN FLUORIDE	HF	7664-39-3	30	NIOSH REL 3 ppm	4	313
HYDROGEN SELENIDE	H_2Se	7783-07-5	1	-	4	1.8
HYDROGEN SULFIDE	H_2S	7783-06-4	100	NIOSH REL 20 ppm	4	444
HYDROGEN TELLURIDE	H_2Te	7783-09-7	-	-	4	-
NICKEL TETRACARBONYL	$Ni(CO)_4$	13463-39-3	2	NIOSH REL 0.001 ppm	4	9.642
NITROGEN DIOXIDE	NO_2	10102-44-0	13	NIOSH REL 5 ppm	3	99
OSMIUM TETROXIDE	OsO_4	20816-12-0	0.001	NIOSH REL 0.0002 ppm	3	40
OXYGEN DIFLUORIDE	OF_2	7783-41-7	0.5	NIOSH REL 0.05 ppm	4	26.067
PERCHLORYL FLUORIDE	$ClFO_3$	7616-94-6	100	NIOSH REL 3 ppm	3	385
PERFLUROISOBUTYLENE	C_4F_8	382-21-8	-	NIOSH REL 1.2 ppm	-	17
PHOSGENE	CCl_2O	75-44-5	2	NIOSH REL 0.1 ppm	4	0.5-1.5
PHOSPHINE	PH_3	7803-51-2	50	NIOSH REL 0.3 ppm	4	0.44
PHOSPHOROUS PENTAFLUORIDE	PF_5	7647-19-0	25	OSHA PEL 0.25 ppm	4	-
TABLE 1. CHEMICAL NAME	**Chemical Formula**	**CAS #**	**NIOSH IDLH (ppm)**	**OSHA PEL/NIOSH REL**	**NFPA Rating**	**LC50 (ppm)**
SELENIUM HEXAFLUORIDE	SeF_6	7783-79-1	2	OSHA PEL 0.05 ppm, NIOSH REL 0.05 ppm	3	-
SILICON TETRACHLORIDE	$SiCl_4$	10026-04-7	-	OSHA/NIOSH REL 5 ppm	3	8000
SILICON TETRAFLUORIDE	SiF_4	7783-61-1	-	-	3	922
STIBINE	H_3Sb	7803-52-3	5	OSHA/NIOSH REL 0.1 ppm	4	-
DISULFUR DECAFLUORIDE	S_2F_{10}	5714-22-7	1	-	4	2
SULFUR TETRAFLUORIDE	SF_4	7783-60-0	-	OSHA/NIOSH REL 0.1 ppm	3	40
TELLURIUM HEXAFLUORIDE	TeF_6	7783-80-4	1	NIOSH REL 0.02 ppm	-	-
TETRAETHYL PYROPHOSPHATE	$C_8H_{20}O_7P_2$	107-49-3	5	-	4	-
SULFOTEP	$C_8H_{20}O_5P_2S_2$	3689-24-5	10	NIOSH REL 0.2 ppm	4	38
TRIFLUOROACETYL CHLORIDE	C_2ClF_3O	354-32-5	-	-	-	-
TUNGSTEN HEXAFLUORIDE	WF_6	7783-82-6	-	OSHA PEL 2.5 ppm	3	218

Any labs using these chemicals will also be required to submit a hazardous chemical SOP to the chemical hygiene officer for review. Proper hazardous chemical SOPs are necessary to ensure all personnel has been trained and are aware of hazards as well as having all forms of engineering and administrative controls and PPE requirements in place to prevent exposure and injury.

Chronic toxicity refers to a chemical's ability to inflict systemic damage as a result of repeated exposures, over a prolonged time period, to relatively low levels of the chemical and often irreversible.

Examples include:

- Asbestos
- Lead
- Tobacco

A single cigarette is unlikely to have a toxic effect on someone, but smoking numerous cigarettes over the course of an entire lifetime will result in the development of toxicity.

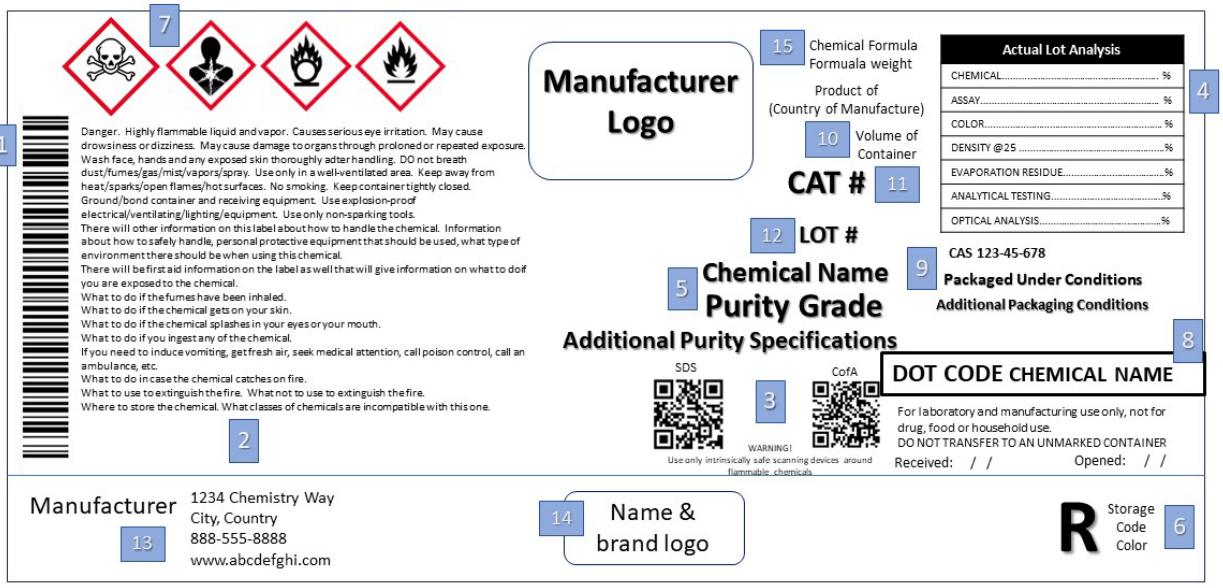
7.9 Assessing the Risk of Chemicals

To assess the risks of a particular chemical, review the safety data sheet (SDS). Each SDS will have the information on risks associated with that chemical.

Another place to find information, especially on risks and hazards of the chemical is on the original container label, figure 7.1. The chemical label will have hazards, emergency information and storage requirements. Original chemical container labels are required to have the following information:

1. Barcode
    a. Code used by industry for inventory and tracking control.
2. Precautionary Signal Word (DANGER, WARNING, CAUTION)
    a. Highlights potential health hazards, both acute and chronic
3. QR Codes
    a. SDS and Certificate of Analysis information
4. Maximum limits of impurities
5. The full product name and purity grade
6. ChemAlert Guide
    a. The color code that matches the cap giving a clear identification of what chemical it is
7. GHS Pictograms
8. DOT shipping information
    a. Includes the DOT proper shipping name, U.N./N.A. number.
        i. Identifies United Nations of North American numerical designation for transportation hazards.
9. Product Composition and CAS#
10. Package Size (per unit)
    a. Liters (liquids), Grams (solids)
11. Catalog #
12. Lot #
13. Contact Information
14. Name and Logo of manufacturer
15. Chemical Formula

Figure 7.1. Example of an Original Chemical Bottle Label



7.10 Safety Data Sheets (SDS)

Any lab personnel using or handling chemicals should review the SDS for that chemical before opening or working with it, especially if it is the first time. Safety data sheets are made available to every person in the area where the chemicals are stored and used.

To ensure that SDSs are readily accessible to employees for all hazardous chemicals in their area, UAB has subscribed to the **ChemWatch** chemical database system. The ChemWatch database may be accessed from any computer on the UAB campus, within the UAB Medical system, or connected via VPN.

An SDS has fifteen (15) sections and will contain:

- Chemical name and identification
- Hazard identification
    - Pictograms
    - Signal Word(s)
- Personal Protective Equipment (PPE)
- Disposal Requirements

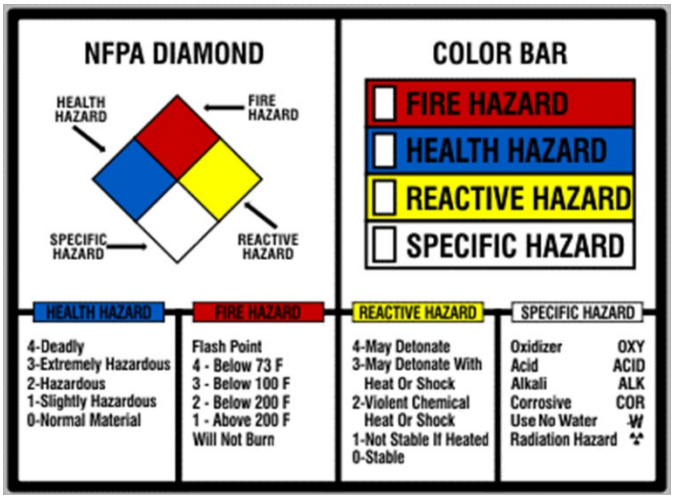
For information on how to get access to SDS at UAB and learn how to properly read the SDS, visit the **ChemWatch** database.

For information on how to use ChemWatch, click here. **Learn how to search the ChemWatch database.**

7.11 NFPA Diamond and HMIS

The National Fire Protection Association (NFPA) diamond is also known as the "Fire Diamond" used by emergency personnel/first responders to quickly identify the risks posed by chemicals. The diamond helps determine if any special equipment should be used, procedures followed, or precautions taken during the initial stages of an emergency response. Each diamond, if that hazard exists with that chemical, will be scaled 0-4 with 4 being the highest hazard risk. Safety Data Sheet hazardous communication (HAZCOM) categories rank opposite to the HMIS, NFPA ratings where in HAZCOM ratings, 1 is the most severe hazard and 5 is the least severe. Something to keep in mind when comparing an SDS and an NFPA diamond/HMIS color bar, the NFPA diamond has 4 color-coded diamonds within it and they are:

- Red – Flammability
- Blue – Health hazards
- Yellow – Chemical reactivity
- White – Special hazards
    - Examples:
    - OX – oxidizer
    - W – Water reactive (violently)
    - SA – Simple asphyxiant



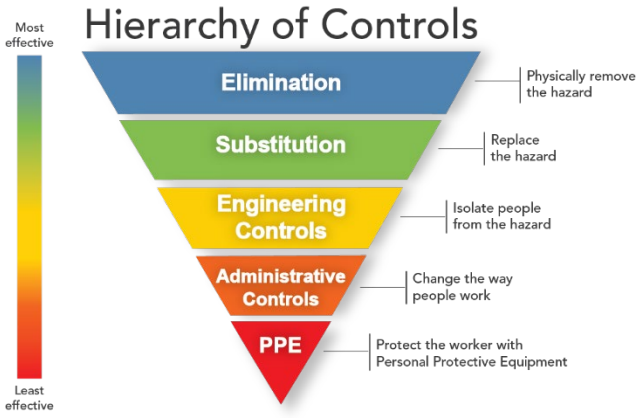
The HMIS color bar also utilizes red, blue, yellow and white.

7.12 Hierarchy of Controls

There is a hierarchy of controls when it comes to exposure control methods. The hierarchy is set up as an inverted pyramid with the most effective control at the top being complete elimination of the hazard. At the bottom, as the lowest or "last line of defense" is personal protective equipment (PPE).

The levels in the hierarchy are:

- Elimination
    - Design the work in a way that physically removes the hazard altogether.
- Substitution
    - Substitute with a less hazardous alternative or a safer method/procedure
        - Example: replace carcinogenic benzene with hexane wherever possible
- Engineering Controls
    - Isolate the problem at the source.
        - Use of fume hood or glove box for chemicals that are potentially hazardous or toxic.
- Work Practice/Administrative Controls
    - Training for proper and safe handling of the material
    - Reducing the amount of time that a lab worker spends using or being exposed to that material.
- Personal Protective Equipment
    - Lab coats – appropriate lab coats to be worn whenever work at the bench is being conducted.



- Gloves – appropriate gloves to be worn any time chemicals or biological solutions are being used.
- Eye protection – appropriate eye protection should be evaluated based on the nature of the experimental work occurring within the laboratory.
    - Example: Organic synthesis laboratories should wear chemical splash goggles as opposed to safety glasses which will not protect from splashes or vapors/fumes.

7.13 Engineering Controls (Fume Hoods)

The main form of engineering controls for laboratories using hazardous chemicals is a chemical fume hood. The following are general ventilation guidelines for laboratories:

- Must have mechanically generated supply and exhaust air.
- Must use 100% outside air and exhausted it out completely.
- Fume hood exhaust shall not be returned to the building.
- Cabinetry, equipment, storage and other structures shall not block supply/exhaust vents to avoid obstructing the efficient circulation of air.
- Must ensure that the amount of air exhausted and the amount supplied are adjusted to maintain a negative pressure between the laboratory and the adjacent spaces.
    - Pressure differential prevents hazardous vapors/agents from escaping the laboratory.
    - As a general rule: airflow should be from areas of low hazard unless the laboratory is used as a clean or sterile room.
    - *Exception: clean rooms may require a slight positive pressure differential. There should be separation between common spaces and the clean room to prevent migration of airborne contaminants.

For more information on fume hoods, refer to the Fume Hood section of the manual.

7.14 Administrative/Work Practice Controls

UAB has established several administrative controls for its laboratory operations and other areas where chemicals are handled. These controls define the requirements for safe use of chemical hazards. Administrative controls consist of various policies and requirements that are established at an administrative level (e.g., by the PI, laboratory supervisors, department chairs, department safety committees, or EH&S) to promote safety in the laboratory. They may include:

- Standard Operating Procedures
- Hazard Assessment
- Labelling and transfer guidelines
- Management of unattended or overnight experiments
- Pre-Approvals of hazardous work
- Housekeeping

7.15 Standard Operating Procedures

The **OSHA Laboratory Standard** requires that chemical hygiene plans (CHP) include specific elements and measures to ensure employee protection in the laboratory. The standard operating procedure (SOP) is the mechanism by which safety and health considerations are conveyed to the laboratory personnel. SOPs are developed for handling of all chemicals with a signal word (such as "Danger") on the chemical label. SOPs, developed by the PI (and approved by the chemical hygiene officer) should establish appropriate work practices, methods of control, measures for the use and maintenance of PPE and special precautions for work with particularly hazardous substances or processes. Standard operating procedures can be stand-alone documents or supplemental information included as part of the CHP, experiment documentation or research proposals. At a minimum, SOPs should include details such as:

- The chemicals and equipment involved and their hazards including quantities and concentrations.
- Routes of exposure and exposure limits.
- Engineering controls (e.g. fume hoods and BSCs)
- Use of PPE
- Exposure monitoring
- Spill response measures.
- Emergencies
- Training
- Waste disposal procedures.
- Decontamination procedures
- Detailed protocol/description of how to perform the experiment.

It is the responsibility of the PI to ensure that SOPs are developed and communicated with the chemical hygiene officer. It also the responsibility of the PI to develop practices and procedures that are adequate to protect laboratory personnel using hazardous chemicals. EH&S has developed a template for the hazardous chemical SOPs and can assist laboratories in developing lab specific SOP. **Hazardous Chemical SOP Template**

7.16 Hazard Assessment

7.16.1 Chemical labeling standards

Shipping containers are shipped with labels containing information regarding:

- product identifier
- signal word
- pictograms
- hazard statements
- precautionary statements
- name, address and phone number of the responsible party.

The best way to label the container is to never remove or deface the original label, placed on the container by the supplier.

Workplace containers can be labeled with alternative methods are described below.

All original chemical containers (hazardous and non-hazardous) must be prominently and accurately labeled with:

- Full chemical name.
- Appropriate hazard warnings.
    - Health and physical hazards
        - Can be GHS pictograms or words.
        - Chemical container labels can be generated using **ChemWatch**
- Must be in English.
- Must be legible.
- Indicate date received and date opened on the container.
    - Especially important for peroxide formers and other chemicals that become unstable over time.
- No formulas or abbreviations on ANY containers (original or secondary).

Pictogram information and labels can be found at **Hazard Communication Standard Pictogram - OSHA**

7.17 Labeling and Transfer of Chemicals

When transferring chemicals from the original container to a secondary or portable container, the containers must also comply with the labeling requirements listed above:

- The chemical is not used within the work shift of the individual who made the transfer.
- The individual who made the transfer leaves the area.
- The chemical is moved to another area and is no longer in the possession of the individual who made the transfer.

Chemical labels can be generated for both primary and secondary containers using **ChemWatch.**

All personnel working with chemicals must be properly trained on how to label chemicals using ChemWatch. Training should occur during onboarding and *at a minimum*, annually.

7.18 Pre-Approvals

Pre-approvals require approval prior to the purchase of certain chemicals and additional control measures for certain particularly hazardous activities.

Prior approval ensures that the laboratory personnel have received proper training on hazards and that safety considerations have been considered ***before*** a new experiment or area of research begins. This also eliminates the chances of unauthorized experiments from being performed in the laboratories.

Environmental Health and Safety can provide guidance on identifying experiments, equipment and situations that may require PI pre-approvals.

Situations that may require pre-approvals of the PI include but are not limited to:

- Areas of research involving particularly hazardous substances (PHSs)

- Personnel working after-hours with hazardous materials such as:
    - Pyrophorics
    - Highly reactive chemicals or compounds
    - Hazardous equipment
- Scale up of an experiment that involves the use of highly hazardous materials.
- Use of new or dangerous equipment

7.19 Unattended Experiments

If lab personnel initiate automated equipment or experimentation that is potentially dangerous and must leave it unattended for any length of time or even overnight, the generally acceptable safety procedures should be met. These procedures include:

- Any necessary arrangements must be finalized prior to experimentation.
    - Someone should check the lab periodically.
    - If the procedure involves continuous utilities such as water/power, confirm the department has not received notice of planned shutdowns.
- Observe all fire precautions.
    - No open flames should be left unattended – NO EXCEPTIONS
    - Over-temperature cutoff devices should be used on heated oil baths that run unattended.
- Post a notice on or near the experiment.
    - Notice should clearly communicate:
        - Emergency shut-off procedures.
        - Nature of the hazard(s)
        - Contact information for the person responsible for the experiment and the PI or lab manager.
- Post a notice on the laboratory door.
    - Notice should clearly communicate:
        - Nature of the hazard(s)
        - Contact information for the person responsible for the experiment and the PI or lab manager.
- Provide items appropriate for the containment of toxic substances.
    - In the event of failure of a utility service (such as cooling water) to an unattended experiment.
- Whenever possible, use automatic shutoff devices for long term or unattended operations.
    - Be mindful of potential situations such as loss of cooling water and overheating, etc.
- Be aware
    - If alarms or safety equipment/systems are activated due to an unattended experiment malfunction, the PI responsible for the experiment could be responsible for damages to the building, lab spaces, equipment, etc.

7.20 Housekeeping

Housekeeping is and should be a major consideration when planning and executing any laboratory work. Housekeeping is general cleanliness, orderliness and maintenance of the laboratory. Housekeeping also includes storing items in appropriate areas that meet their storage requirements and compatibilities. The function of good housekeeping is to ensure the safety of personnel and smooth functioning of the laboratory. Good housekeeping is particularly important in preventing accidents, fires, and injuries caused by trips and falls as well as chemical spills.

Good housekeeping includes:

- Keeping the floors and bench tops free of clutter, trash and unused chemical containers.
- Keeping refrigerators and freezers properly labeled, segregated and clutter free.
- Keeping chemical storage areas properly segregated, labeled and clutter free.
- Keep all chemical containers labeled and closed at all times.
- Keep emergency showers, eyewash stations, fire extinguishers, first-aid kits and spill kits readily accessible, in good working condition and unobstructed.
- Keeping electrical panels and emergency shut offs unblocked and unobstructed.
    - A minimum of 36 inches of clear perimeter.
- Keeping aisles, exits and corridors clear of obstacles and tripping hazards.
    - Bottles
    - Boxes
    - Equipment
    - Electrical cords
    - Etc.
- Keep all exits unobstructed.
- Immediately sort and store chemicals arriving in boxes appropriately and not stored on the floor or stacked against the wall.
- Do not store equipment on the floor or walkways.
- Do not place equipment in places where it will protrude into aisles and walkways.
- Clean up any spills immediately (using spill kit if necessary)
    - Use **Spill Decision Tree** **to determine if emergency assistance is required.**
    - **If spill is cleaned up in-house with lab spill kit, notify EH&S when safe to do so at 205-934-2487.**
- Keep areas around sinks and fume hoods clear and organized.
    - Especially sinks with eyewash stations located beside the sink.
- Keep chemicals off the floor.
- Keep glassware off the floor.
- Keep any materials off the floor to avoid tripping hazards.
- Store combustible materials away from entry/exit ways.
- Do not store glass bottles above eye level.
- Do not store oxidizing chemicals above eye level.
- Keep bulkier/heavier items closer to the floor.
- Do not store any materials within 18 inches of the ceiling for a sprinklered room.
    - Ensures sprinkler coverage is not impeded.

- Do not store any material within 24 inches of the ceiling for an un-sprinklered room.
    - For first responders to circulate water effectively.
- Maintain a current chemical inventory via EHSA, disposing of unwanted or expired chemicals regularly.
- Remove regulators from empty or unused compressed gas cylinders and replace the cap.
- Dispose of empty gas cylinders as soon as possible.
- Conduct regular self-inspections of the laboratory to ensure good housekeeping and safety regulations are within compliance of EH&S.

It is the responsibility of the PI and laboratory supervisors to ensure laboratories under their supervision are maintaining good housekeeping and personnel are working in a manner that is safe and using best practices where safety is concerned.

7.21 Eating, Drinking and Applying Cosmetics

Chemical and other toxic materials exposure can occur through ingestion of contaminated food or drink or chewing gum. This type of contamination can occur when food or drinks are brought into a laboratory or when food or drinks are stored in refrigerators, freezers or cabinets with laboratory materials. Chemical exposure can occur if contaminated food or drink is consumed. Eating or drinking in areas exposed to toxic materials is prohibited by the OSHA Sanitation Standard, 29 CFR 1910.141(g)(2).

A similar principle of potential chemical exposure can occur if cosmetics are applied in the laboratory. Cosmetics can be contaminated by any fumes, dusts or vapors that may be present in the laboratory in the same manner as food or drink. To prevent exposure to hazardous chemicals through ingestion or skin contact, do not eat, drink, chew gum or apply cosmetics in areas where these materials are used.

7.22 Personal Protective Equipment (PPE)

All individuals, including visitors, who enter areas where hazardous materials are used or stored, must wear appropriate PPE. All personnel should know where and how to access the proper PPE for the laboratory. All personnel should know how to properly use, maintain and dispose of PPE. PPE is the last line of defense against potential exposures. It is never a substitute for engineering controls and prudent work practices but should be used in conjunction with the other controls to ensure the safety and health of everyone in the laboratory.

PPE should be kept at or near the entrance/exit to the laboratory. All protective wear (lab coats, gloves, etc.) used at the bench should be kept inside to minimize the possibility of spreading contaminants to public areas including break and office areas, where eating, drinking and office work occur. Personal protective equipment assessment and types can be found in the PPE section.

7.22.1 PPE Assessment

The **OSHA Personal Protective Equipment (PPE) Standard (29 CFR 1910.132)** states that employers are responsible for:

- Conducting a hazard assessment to identify the appropriate PPE.
- Making PPE available to all employees.
- Training employees in the use and care of the PPE.
- Having a PPE maintenance program
    - Including replacing worn or damaged PPE

Laboratory personnel/students/visitors are responsible for:

- Wearing/storing PPE properly.
- Attending all training sessions.
- Taking care of PPE.
- Notifying the supervisor of the need for new or additional PPE.

Laboratory personnel will be provided with PPE that is *required* to perform assigned laboratory duties/responsibilities safely. Students may be required to purchase PPE. Gloves should be provided by the laboratory.

7.23 Four Components of Laboratory PPE Program

1. Hazard Assessment
2. Employee Training
3. Supervisor Verification of PPE use.
4. Guidelines for PPE selection.

Regarding PPE use and selection, employers are required to train employees on:

- Proper use of PPE:
    - When to use PPE.
    - What type of PPE is required.
    - Proper donning and doffing of PPE.
    - Limitations of the PPE.
    - Proper care, maintenance and disposal of PPE.
- PPE Selection
    - Chemicals/biologicals being used.
        - Concentration
        - Quantity
    - Hazards the material(s) pose.
    - Routes of exposure.
    - Material of which PPE is constructed.
    - Permeation and degradation rates specific chemicals will have on the material.
    - Length of time PPE will be in contact with chemical/material.
        - Gloves should be changed every hour (or as needed) to ensure appropriate protection.

- Comfort/fit of PPE.
  - Proper fit ensures personnel will actually wear the PPE.

7.24 Exposure Monitoring

UAB Environmental Health and Safety can monitor exposure levels to any substance regulated by Occupational Safety and Health Administration (OSHA) or the American Conference of Governmental Industrial Hygienists (ACGIH). Results of this testing may be compared to OSHA permissible exposure limits (PELs), ACGIH threshold limit values (TLVs), NIOSH recommended exposure limits (RELs), or other applicable guidelines to make recommendations for the most effective engineering controls, work practices, and PPE. For more information on exposure monitoring please visit the link listed here. **https://www.uab.edu/ehs/services/monitoring**

7.25 Routine Monitoring

Routine monitoring may be initiated under several conditions if:

- There is reason to believe exposure levels exceed the designated action level (usually one half the PEL).
- A regulatory agency mandates regular monitoring.
- A change in a procedure may significantly change employee exposure to a substance.
- The action level is exceeded.
  - Corrective procedures will be recommended, and monitoring will be repeated periodically as required by the standard.
- The action level is not exceeded on either the initial or follow-up monitoring.
  - Monitoring may be discontinued as allowed by the standard.
- In certain circumstances, it is necessary to verify that work practices and engineering controls are effective in limiting exposures to hazardous materials.

Assessment of exposure to other chemical and physical agents can be requested. For more information, contact EH&S at 205-934-2487.

These chemical and physical agents include:

- Solvents
- Dust
- Silica (dust)
- Lead
- Carbon Monoxide (CO)
- Nitrogen Dioxide (NO_2)
- Explosive gases
- Oxygen (O_2)
- Noise
- Total illumination
- Non-ionizing electromagnetic radiation

The Radiation Safety Program measures exposure to ionizing radiation. If it is suspected that there are exposures in excess of exposure limits (such as symptomology associated with exposure), contact EH&S at 205-934-2487 or ChemicalSafety@uab.edu.

7.26 Risk Assessments Before Starting Work with Hazardous Materials

- Identify hazardous materials to be used, amounts and circumstances of use in the experiment.
- Consider any special employee or laboratory conditions that could create or increase a hazard.
- Research and gather information by referring to sources of safety and health information (e.g., SDS) and consult with peer reviewed publications and subject matter experts.
- Evaluate the hazards posed by the materials and the experimental conditions.
    - Toxic
    - Physical
    - Reactive
    - Flammable
    - Explosive
    - Radiation
    - Biological
    - Any other potential hazards
        - Scale up can pose additional risks
- Evaluate appropriate controls to minimize and mitigate the exposure risks, including:
    - Use of engineering controls
    - Administrative controls
    - PPE
    - Controls must ensure OSHA's PELs are not exceeded.
- Prepare for contingencies and be aware of the institutional procedures in the event of emergencies and accidents.
    - **Lab Emergency Resource**

CHAPTER 8: GENERAL LABORATORY PRACTICES

8.1 Housekeeping

- Eliminate clutter; keep benchtop clear.
- Remove any materials that may be a trip hazard.
- Use caution when walking through doorways with open chemicals and materials.

8.2 Proper Storage

- Sturdy shelves with lip/ledge or barrier to prevent things from falling off.
- Proper chemical segregation in storage areas
    - Flammables
    - Oxidizers
    - Acids
    - Bases
- Large containers stored close to the floor.
- No storage on the floor.
- No storage in fume hoods.
- No cardboard in cold cabinets.
- Minimal storage on the lab bench.
- Periodic inspection of storage areas for the condition of the containers.

8.3 Chemical Transport

- Use sturdy laboratory carts with lip.
- Use secondary containment for ***all*** chemicals.
- Keep solvents in safety cans (secondary containment as received)
- Use rubberized buckets with handles.
- Chemicals may be moved only by properly trained lab workers.
    - Training must be documented.
- Use freight elevators.

8.4 Transfer of chemicals between containers

- Do not overfill.
- Provide spill containment or absorbent paper.
- Use compatible containers as secondary containment (refer to SDS for compatibility).
- Secondary containment containers must also be labelled with the chemical name being transported.
-

8.5 Basic Safety Rules for Laboratories

8.5.1 General Rules

These rules must be followed in all laboratories (including clinical laboratories) using hazardous or potentially hazardous materials.

- Avoid routine exposures.
  - Do not smell or taste chemicals.
  - Minimize skin contact whenever possible.
  - Any apparatus that might give off fumes from toxic materials/chemicals should be vented/exhausted or in a fume hood (i.e., vacuum pumps, distillation columns, etc.)
  - Inspect glove boxes and the gloves before use.
- Avoid "horseplay"
  - Do not engage in any behavior that may distract another worker or may cause harm to you or others.
- Choice of chemicals
  - Only use chemicals for which there is available, adequate ventilation and safety equipment.
- Eating, drinking, smoking (**No Food or Drinks in the Lab**)
  - Do not eat, drink, smoke, chew gum or apply cosmetics in the laboratory.
  - Do not consume food or drinks with glassware or utensils that are used in the laboratory.
  - Never store food or drinks in refrigerators, freezers or storage areas containing chemicals.
  - Always wash hands before and after any activity involving the use of chemicals.
- Mouth pipetting
  - Never use mouth suction for pipetting or starting a siphon.
- Personal apparel (**Lab Attire and Best Practices**)
  - Long hair should be tied back.
  - Avoid loose clothing, especially in long sleeves.
  - Long pants are required when working in the laboratory.
  - Shorts, skirts and capris are not acceptable laboratory attire.
  - A lab coat must be worn when working in a biosafety cabinet.
  - Closed-toed and closed-back shoes are required in the laboratory.
  - Shoes should be hard soled and water/liquid resistant.
  - Cloth shoes are not acceptable for the laboratory.
  - Sandals, open-toed or perforated shoes are not acceptable for the laboratory.
  - Slip-on shoes are also not acceptable for the laboratory.
- Personal Protective Equipment (**Lab Attire and Best Practices**)
  - All persons in the laboratory, including visitors must wear safety glasses with side shields or goggles.
  - Gloves should be worn when working with any chemicals. Gloves should be inspected and replaced as necessary.
  - No contact lenses should be worn in the laboratory. If contacts are necessary, supervisor must be notified, and precautions taken for alternate eye protection.
  - Anyone working in a biosafety cabinet must wear a clean, buttoned (or snapped) lab coat made of appropriate material.
- Housekeeping (**Housekeeping and Door Propping**)
  - Work areas and bench areas in the laboratory must be kept clean and free of clutter.
  - Chemicals and equipment should be properly labelled and stored.

  - Every person in the lab, including visitors, must have access to an eyewash station and emergency shower (Not further than 10 seconds travel time and no doorways or obstructions for the travel to the unit).
  - Eyewash stations should be inspected weekly.
  - Emergency safety showers should be inspected regularly, but at a *minimum*, annually.
- Planning (**Planning makes for safer experiments**)
  - Experiments should be planned carefully, with safety incorporated into every aspect.
  - Written protocols should be in place and lab workers appropriately trained prior to starting the experiments or operations.
  - Any laboratory experiment or activity should consider all materials and equipment being used, as well as any necessary administrative controls, engineering controls and PPE.
- Use of fume hoods (**How To Properly Use and Operate a Fume Hood**)
  - Use a certified fume hood for operations that might result in the release of toxic chemical vapors, gases or dusts.

8.6 Working Alone

EH&S recommends that no one work alone in the laboratory, especially with hazardous materials/chemicals. But EH&S recognizes that there are circumstances where this may be necessary. If there is not a partner who can be physically present, UAB Rave Guardian can provide a "virtual buddy" to assist in case of emergency. Rave Guardian is a free app that can be accessed by the link provided (https://www.uab.edu/emergency/rave-guardian).

Any situation where working alone is necessary, **the worker must have prior written authorization from the responsible PI or laboratory manager of that laboratory**.

- The PI must limit working alone to experienced workers only.
- The PI must evaluate activities that help to mitigate or prevent an accident or injury to the person working alone.
- The PI must establish a process to summon help immediately in case of an accident.
- The PI must limit work to certain hours so that people may be working in nearby laboratories.

EH&S is available to assist in establishing procedures to mitigate the hazards risk.

8.7 Unattended and After-Hours Laboratory Work

- Unattended and after-hours experiments must have permission of the PI/supervisor.
  - the worker must discuss all steps involved in the experiment with the PI.
- The PI must evaluate activities that would help mitigate or prevent an accident that could be released hazardous materials to the environment damage the facility or cause harm to the worker.
- The worker is responsible for ensuring that the experiment or work will not release any hazardous material during the process.
- Any after-hours work involving any hazardous materials should be performed exclusively in the fume hood.

- Interruptions in utility services such as electricity, cooling water etc. must also be taken into consideration while planning the experiment or work.
- Laboratory lights must stay on while the worker is in the lab alone.
- There must be signage posted on the laboratory door identifying the nature of the experiment or work and hazards involved.
- Emergency contact information must be posted on the laboratory door.
- The operation should be periodically checked by other laboratory workers to ensure safety.

Contact EH&S at **205-934-2487** or ChemicalSafety@uab.edu for guidance or assistance in developing a plan for after-hours laboratory work.

8.8 Training

University policy recommends that anyone working with, or handling chemicals receive training to be informed of the potential health and safety risks that may be present in their area. This includes faculty, staff, students and visitors. Documentation must be maintained to demonstrate that training was completed. To fulfill this requirement, EH&S has developed a training program. This program has two components: web-based and classroom-based training. The training can be accessed on the EH&S website, under the **Training** tab.

UAB follows guidance provided in the OSHA Laboratory Standard for training, timing of training and maintaining documentation of training. All students, employees (including temporary employees), and visitors must receive information and training on the following:

- The requirements of the Hazard Communication, Chemical Safety and Waste Management Programs.
- Locations where hazardous materials/chemicals are present.
- The physical and health hazards of the materials/chemicals present.
- How to read and interpret chemical labels and their SDS.
- Methods and observations used to detect the presence of hazardous materials/chemicals.
- The location and availability of the CHP, SDS, SOPs, hazardous chemical inventory and any additional reference material.

The OSHA laboratory standard is specific to working with hazardous materials/chemicals. Per UAB policy, all employees, students and visitors must be provided with proper training and information related to the other health and physical hazards found in their work environment. Students and employees can visit the **Training** tab to determine the required EH&S courses needed. It is the responsibility of the PI, supervisors and instructors to ensure personnel working in their laboratories are provided the proper training. The PI is responsible for providing information needed to protect personnel from the potential hazards in the laboratory. Training records should be maintained for all personnel in the laboratory.

8.9 Training Methods

Principle Investigators, supervisors, instructors have a variety of options available to ensure that the employees and students receive all required training. Training can be provided by the department, UAB EH&S, and through other resources made available by UAB. It is the responsibility of each PI to develop a training plan and provide all lab and project-specific trainings. Any safety training not provided through UAB EH&S (third-party), must be reviewed and approved through EH&S before offering as an alternative training option.

8.10 Documentation of Training

Any third-party training must be documented. Records of these trainings must include:

- The full name and Blazer ID of the person receiving the training.
- The length, content and type of training.
- The date of training.

8.11 UAB Campus Learning System

Many of the training courses provided by UAB EH&S are available online through the campus learning system. In addition, the campus learning system maintains electronic training records for all online courses completed and any that are assigned. **UAB Campus Learning System**

CHAPTER 9: SHIPPING, RECEIVING and TRANSPORTING CHEMICALS on CAMPUS

9.1 Shipping Chemicals

The Department of Transportation (DOT) and the International Civil Aviation Organization (ICAO) regulate the shipment/transportation of hazardous materials (HM) and dangerous goods (DG). Any UAB faculty, staff or student planning to ship HM or DG must contact EH&S for guidance prior to shipping. Failure to comply with regulatory requirements while shipping may result in citations, fine or even imprisonment.

9.2 Defining Hazardous Materials and Dangerous Goods

Hazardous materials and dangerous goods are materials or substances that can pose a risk to health, safety, property or the environment. Many of the materials used in a research laboratory setting fall into this category. Materials such as chemicals, biological agents, radioactive materials, compressed gases are shipped and received every day.

9.3 Material Transfer Agreements

If it is necessary to send or receive hazardous or dangerous research materials/goods, it should be coordinated through the UAB Materials Transfer Office (MTO) to arrange Material Transfer Agreement (MTA). For information on how to obtain an agreement, refer to the MTO website (**https://www.uab.edu/research/home/mto-processes**).

9.4 Training

Only EH&S trained individuals are allowed to classify, mark, label, package and prepare and maintain appropriate documentation, in accordance with DOT training requirements. Contact EH&S for assistance and identifying the appropriate training requirements. EH&S offers various training courses and can be found here (**CS055: Hazardous Waste Handling & Packing**).

9.5 Shipping Chemicals

If it is necessary to ship chemicals, EH&S must be contacted at least one week prior to the desired shipping date. EH&S will classify the chemical as HM and DG based on DOT and IATA regulations and provide guidance on shipping. Chemicals reviewed by EH&S and classified as non-regulated may be shipped by the laboratory without further assistance from EH&S.

9.6 Shipping with Dry Ice

Shipping some chemicals or biological agents may require packing on dry ice. Anyone planning to package dry ice shipments or sign any type of to sign any type of shipping documentation for a dry ice shipment must complete UAB online training **BIO200: Shipping with Dry Ice**.

9.7 Receiving Hazardous Packages

Anybody receiving a hazardous chemical package must be trained. Laboratory personnel with **CS101: Chemical Safety Training** and Facilities employees with **HS200: Hazard Communication** training will not require additional trainings.

UAB employees and students that receive delivery of hazardous materials (e.g. administrative staff) must be trained to identify hazardous packages and respond to any emergencies like spill or breakage (see link above for HS200 training link).

9.8 Transporting Chemicals on Campus

This guideline applies to the transport of all potentially hazardous chemicals used in laboratories (corrosive, flammable, explosive, reactive, etc.). This includes, but is not limited to, transport between storage rooms and laboratories, between different laboratories, within individual laboratories and from building to building or across campus.

9.9 Recommended Training

- **CS101: Chemical Safety Training**
- **OHS101: Using PPE in the Laboratory**
- **CS055: Hazardous Waste Handling & Packing**
- **BIO200: Shipping with Dry Ice**
- **HS200: Hazard Communication**

For any additional assistance or resources, contact EH&S **205-934-2487**.

9.10 Personal Protective Equipment for Transporting Chemicals

Individuals transporting chemicals must wear appropriate personal protective equipment (PPE). At a minimum, a lab coat and safety glasses/goggles should be worn. Gloves should never be worn outside of the laboratory or the building. The chemical or material should be transported in secondary containment as not to require gloves for transport.

9.10.1 Transport

- Single boxes of chemicals in their original packaging can be hand carried to their destination if they are light enough to manage easily.
    - Groups of packages or heavy packages should be transported on a cart that is

        - Stable
        - Has straps/sides.
        - Wheels large enough to negotiate uneven surfaces safely and easily.
- Individual bottles can be hand carried if placed in an approved secondary container or bottle-carrying bucket to protect against breakage or spillage.
- Chemical containers must be segregated based on the compatibility chart.
- Incompatible chemicals should never be transported on the same cart.

A list of incompatible chemicals can be found **here**

- Secondary containment must be used for liquids
    - Container must be large enough to contain the entire container's material should breakage or spillage occur
- Never use the same secondary containment for chemicals that are not compatible
- Never try to transport expired peroxide formers
    - A list of peroxide formers can be found **here**
- Freight elevators are recommended for the transport of chemicals
    - Passenger elevators are highly discouraged for chemical transport
- If no freight elevator in the building where chemicals are being transported
    - Use elevator during non-peak times
- Chemical containers must be labelled and in proper secondary containment prior to putting on elevator (see above for secondary containment)
- Never ride with passengers while transporting chemicals
- Never transport chemicals in a personal vehicle
    - Coordinate chemical transport through EH&S (205-934-2487)
- Never leave chemicals unattended during transport
- Update the chemical inventory to reflect the move of chemicals
    - **EHSA** is UAB's online chemical inventory system
    - The EHSA tool helps to manage:
        - Chemical inventory
        - Controlled substances
        - Radioactive material inventory
        - Lasers
        - X-rays
        - Hazardous waste pickup
        - Lab/PI registration
        - Lab safety visits
        - Reviews and approvals for the research safety committees
            - Institutional Biosafety (IBC)
            - Chemical Safety and Environmental Management (CSEMC)
            - Radioisotope and Radiation Safety (RRSC)
            - Subcommittee for human use – Radioisotope and Radiation Safety (SCHU)
            - Laser Safety Advisory (LSAC)

If the laboratory is moving to another location on campus, please consult with EH&S before planning the move and follow the UAB lab move/close out policy:

Lab Move, Closeout, & Equipment Tagout

Before the move, it is recommended to:

- Dispose of all expired or outdated chemicals
- Dispose of chemicals that you will no longer use
    - Dispose of these chemicals through EH&S hazardous waste pickup
    - Never dump unwanted chemicals down the drain or into the trash
- If there are chemicals that are no longer needed but still in date and good condition, donate to other laboratories if possible
    - The chemicals donated must be transferred to the new laboratory in EHSA
- Never transport expired peroxide formers to a new lab location or donate to another laboratory
    - Dispose of these chemicals through EH&S hazardous waste pickup
- Do not move any chemical waste to a new laboratory location
    - Dispose of these chemicals through EH&S hazardous waste pickup
- Unknown and/or unlabeled chemicals are not permitted to be moved to a new laboratory location
    - Every effort should be made to identify any unknown/unlabeled chemicals for proper disposal
    - If they cannot be identified, outside vendors will be contracted by EH&S to identify the unknown chemicals
        - The department of that laboratory will be responsible for costs incurred

9.11 Spill Response During Transport

During transport, if a spill occurs, follow procedures described in UAB response plan

Hazardous Materials Spill Procedures

If you are not comfortable in cleaning up or handling the spill, call the EH&S emergency on-call number (205-917-4766) for further assistance on spill cleanup and dispatch of hazardous waste cleanup.

Never try to clean up a spill if:

- You are not sure of the material that spilled
- More the one chemical has spilled
- Quantity is more than you can comfortably handle
- It is not a “small” spill
- You are not trained in spill response
- There is not enough appropriate spill cleanup material or PPE available
- Chemical is highly flammable
- Chemical is reactive
- Chemical is toxic
- Chemical is on fire or has potential for fire

9.12 Managing Inventory for a Location Change

- Make sure all disposed chemical containers are removed from your online chemical inventory:
  - **EHSA**
- If chemicals are being moved from one location to another, appropriate change of location should be documented in EHSA
- If chemicals are being donated to another laboratory/PI, inventory for both donating and receiving laboratory should be documented in EHSA

CHAPTER 10: LABORATORY SECURITY

10.1 Safety vs. Security

Laboratory safety practices are intended to protect people from accidental exposure to hazardous materials. Laboratory security practices are intended to provide protection, control and accountability for valuable materials to prevent their unauthorized theft, misuse, diversion or intentional release. In broad terms, laboratory safety keeps people safe from hazardous materials and laboratory security keeps hazardous materials safe from people.

10.2 Dual-Use Materials

Many common laboratory chemicals/biologicals have both beneficial and harmful uses. Those materials are called "dual-use" materials. Some of the dual-use chemicals are regulated as chemicals of interest. The regulatory concept of a chemical of interest is considered as "any toxic chemical or its precursor that can cause death, injury, temporary incapacitation or sensory irritation through its chemical action". Dual-use chemicals can be stolen from laboratories and can be used in making explosives/weapons and or other illegal activities. Laboratories need to take specific actions to secure materials in the laboratory and provide security against theft and misuse of dual-use materials, valuable equipment and intellectual property.

10.3 Security Expectations

10.3.1 PI/Laboratory Manager

- Maintain accurate chemical inventory
- Maintain constant awareness of possible theft or diversion of chemical.
- Maintain a physical presence in or near the laboratory during hours of operation
- Develop and maintain a formal policy prohibiting the improper use of laboratory facilities or materials
- Maintain familiarity with experiments and chemicals/volumes being used in the laboratory
- Reporting unauthorized purchases or deliveries to EH&S
- Monitor and authorize the specific use of dual-use materials
- Regularly review access controls for the laboratory
- Maintain log of those gaining access to dual-use materials
- Identify and authorize laboratory personnel responsible for various chemical security activities
- Train authorized personnel on safety risks of all hazardous materials
- Follow UAB policies and procedures for laboratory close out and decommissioning prior to leaving the university or vacating laboratory space
- Collect keys and badges whenever personnel access is no longer needed

10.3.2 Laboratory Personnel

- Work safely and safeguard chemicals/materials
- Preplan all experiments and do not deviate from laboratory SOPs and PI authorizations
- Follow all safety and security protocols

- Report any suspicious activity or theft of chemicals/materials
- Participate in security training programs
- Turn in keys and badges to PI when laboratory employment ends

10.4 Types of Security Risks

UAB laboratories face many security risks from inside and outside the facility. Some of the risks may affect only the laboratory while others could have a broader impact, affecting the whole institution and even the public if not managed properly. A good laboratory security system can lessen several risks:

- Theft or diversion of hazardous materials and important equipment
    - Equipment stolen from
        - Laboratories and department stock rooms
        - Diverted in transit between supplier and laboratory or loading dock to sell or misuse
- Threats from activist organizations
- Intentional release of hazardous materials by people from inside or outside UAB
- Sabotage or vandalism of chemicals/experiments/equipment
- Theft or release of sensitive information
- Unauthorized laboratory experiments

The level of security needed for a laboratory or institution depends on the history of past incidents like theft or sabotage, threat directed at the laboratory or institution by outside groups and the presence of hazardous materials or valuable equipment. At a minimum, laboratories should be secured by locked doors when not occupied.

10.5 Laboratory Security Risk Management

The management of risk always starts with a risk assessment and quantification of the risks. Each lab must conduct a risk assessment to identify the security and repeat the process if any of the following situations arise:

- Lab renovation
- Lab relocation
- Introduction of new significant hazard
- Changes in regulation
- Identification of a new hazard

Risk assessment is a collaborative effort and EH&S is available to work with laboratories to complete the assessment. The risk assessment process allows the laboratory or institution to prioritize the assets that need to be protected and the vulnerabilities that need to be addressed.

10.6 Types of Assets to Consider for Risk Assessment

Below are some examples of assets that laboratories should include in the risk assessment process.

- Biologicals, chemicals and toxins
- Equipment
- Laboratory animals
- Intellectual property
- Research data
- Knowledge/research ideas

10.7 Types of Threats to Consider

- Threats from those inside the institution who have inside information and access to sensitive materials or data.
    - Employees
    - Former employees
    - Business associates
- Threats from outside the institution who plan to intentionally harm the laboratory or institution as-a-whole.
    - Terrorist organizations
    - Activist organizations
- Collusion between those inside and outside the institution.

10.8 Risk Management Strategies

Below are the most common security risk management strategies a laboratory or institution could implement to address the risk identified during the risk assessment phase:

- Access control
- Inventory management
- Reporting
- Training
- Personnel Management

10.8.1 Access Control

Access control systems are intended to lessen the risks associated with:

- Theft or diversion of:
    - Critical or high-value equipment
    - Chemicals or biologicals
- Intentional release or sabotage of
    - Sensitive information
    - Chemicals
    - High-value equipment
- Prevent rogue work or unauthorized laboratory experiments

Access control can be divided into 3 major categories:

- Physical security
  - Doors
  - Walls
  - Locks
  - Barriers
- Electronic Security
  - Alarm systems
  - Video surveillance
- Operational Security
  - Sign-in logs
  - ID card readers

10.8.2 Inventory Management

The ability to track and audit laboratory inventory is a basic requirement for most security standards. If there is no asset inventory or the laboratory is not kept up to date, there is a higher risk of not knowing if things have been stolen, misplaced or misused. UAB has an online inventory program (**EHSA**) that can be used to maintain an accurate inventory of everything the lab uses or stores.

10.9 Principles of Inventory Management

Inventory all materials in the laboratory. Below are things for laboratories to consider in maintaining an accurate inventory:

- Receiving all chemical shipments in a central receiving area or preparation area in the laboratory.
  - Barcode chemicals with NFPA rating 2 or higher and add to EHSA inventory
- Include (free) samples of hazardous materials that researched have received from other researchers or universities.
- Keep only the materials that are necessary for operations and disposing of the rest through EH&S Support Facility using **EHSA**.
- Maintain quantities below regulatory limits
- Reconcile the inventory on a regularly scheduled basis
  - At a minimum annually
  - Keep accurate count of materials
  - Newly purchased equipment
  - Remove items that have been consumed or disposed of/manifested through EHSA
- Control Access to Inventory
  - Restrict access to chemicals and sensitive material storage areas only to those authorized
  - Periodically review the laboratory access control process
  - Supervisors/PIs maintain familiarity with chemicals and volumes needed for personnel to reasonably complete experiments
  - Develop a process to monitor and authorize the use of sensitive materials
  - PI and laboratory personnel should maintain a constant awareness of activities authorized in the laboratory

        - Awareness can help deter the idea to personnel or others that the laboratory could be used for illicit or unauthorized activities
- Emergency Communication
    - Laboratories should develop a method of swift communication to the PI and EH&S if any missing shipments, lost inventory or illegal activities are discovered.
- Purchasing
    - Laboratories must have appropriate safety controls and SOPs in place prior to the purchase of hazardous chemicals.
    - Hazardous materials may only be purchased by personnel who have been properly vetted by the PI or laboratory supervisor.
- Training all laboratory personnel
    - Risks of having hazardous materials, sensitive information and equipment
    - Awareness of the possibility of removal of materials or equipment for illicit purposes
    - How to properly report any illegal activity

10.10 Reporting

Reporting involves developing a protocol for reporting any theft/misuse/diversion as well as an emergency communication system.

PIs, in cooperation with UAB physical security, should have policies and procedures in place for reporting and investigating incidents or *possible* incidents. Developing a method for emergency communication, in case of emergency breach or threat is particularly important.

Examples include but are not limited to:

    - Undocumented visitors
    - Missing chemicals
    - Unusual or threatening phone calls
- Laboratories must report all incidents, threats or thefts, etc. to UAB police and EH&S. UAB police will investigate all reported incidents as needed.

10.11 What to Report

- Inappropriate attempt to gain access
- Missing supplies
- Lost or moved equipment
- Requests to borrow materials or equipment from unidentified sources
- Unsolicited requests for technical information in-person or over the internet
- Unusual employment or collaboration requests
- Purchase charged to a laboratory, but material was never received
- Unsolicited delivery of materials

10.12 Personnel Management

- Screening personnel
    - Background check
    - Other screening procedures
- Restriction on after-hours access
- Escorted access
    - Visitors escorted or cleared for entry to laboratory
- Key card access
    - Who has access?
    - How do they get access?
    - All workers should wear visible identification badges
        - Students
        - Visiting scientists
        - Short term workers
    - Badges should include (at minimum)
        - Photograph
        - Wearer's name
        - Blazer ID
        - Issue Date
    - When an employee leaves, keys/badges should be turned in
        - Avoids the possibility of having unauthorized users
- Training on the process of security and personnel management
    - Training should be documented and records kept with other safety training records

10.13 Information Security

Information and data security can be as critical as security of equipment and materials. For more guidance regarding information security, contact UAB IT **UAB Information Technology**

10.14 Training

All members of the laboratory, including volunteers and visitors must be trained on:

- Security awareness
    - Restricting access
    - Type of security measures in place and how to use them.
    - What to do in an emergency or security breach
    - How to:
        - Recognize threat
        - Report suspicious behavior
        - Report vandalism and theft
- Minimizing the purchase, storage and use of hazardous chemicals
- Situational awareness

  - Know who is in the laboratory
  - Have awareness in case of suspicious activity in or around the laboratory
- Training on laboratory security emergency plan

10.15 Laboratory Emergency Plan

Every laboratory is encouraged to have a laboratory emergency plan. This can be a stand-alone plan or can be coordinated with other laboratory safety plans; such as severe weather (tornados, floods, etc.), power outages, and other emergencies. Laboratories may consult building administrators, EH&S and UAB police in developing emergency plans. The **UAB Emergency Response Plan** can help in developing a plan.

The plan should contain provisions for:

- Access control to laboratory areas
  - Building administrators can help to identify safety and security concerns
- Types of equipment and materials in laboratory areas
  - EH&S should be made aware of the equipment and materials
  - EH&S can assist along with UAB police in responses to emergencies in laboratory areas
- Immediate notification of emergency
  - PI/lab supervisor
  - EH&S
  - Others who are knowledgeable of the building, materials, etc.
    - Predetermined by PI and must include names and cell phone numbers
- Assign responsibilities
  - EH&S – provide guidance and training to help develop a plan
  - Building administrators – physical security, building modifications, etc.
  - PI/lab manager – responsible for overall security and the plans
    - PI can delegate to laboratory personnel who will be responsible for various chemical security activities:
      - Chemical tracking and reporting (EHSA)
      - Personnel and access management
      - Information management
      - Emergency planning
    - PI is responsible for providing the resources needed for the laboratory personnel to complete assigned tasks.
    - Emergency protocols and communication should be easily carried out in case of security breach or threat.
    - Periodic review of access controls and emergency plan for effectiveness.
- Personnel are responsible for following safety and security protocols and reporting any suspicious activities.

Resources for laboratory security can be found below. If there are any further questions about developing security plans for the laboratory, contact EH&S at **205-934-2487** or ChemicalSafety@uab.edu.

10.16 Resources

- EHSA
- Prudent Practices in the Laboratory
- Chemical Security for Laboratories
- UAB Emergency Response Plan
- UAB Information Technology

CHAPTER 11: EMERGENCY EQUIPMENT

11.1 Emergency Shower/Eyewash Stations

It is the policy at The University of Alabama at Birmingham (UAB) that all areas using materials considered irritating to the eyes and skin must be equipped with an emergency eyewash and shower to minimize injury to faculty, staff and students due to an unexpected splash of materials that are irritating to the eyes and skin. The entire policy can be found **here**.

The OSHA standard (OSHA 29 CFR 1910.151(c) states that emergency showers and eye wash stations must be present in facilities that handle any hazardous materials. Per the OSHA guidelines, there is a 10 second maximum time it should take for any person to reach an eye wash or emergency shower if they are splashed with a hazardous material/chemical. There should also not be any doors/doorways that would impede that 10 seconds and there should be no obstructions in the path to the emergency shower or eye wash station. Below is a list of the different emergency hardware equipment that can be found in the lab and its intended purpose as well as how and under what circumstances it should be used. Activation/testing of these units should be done at installation and regularly to ensure proper operation, access and hygiene. These tests should be conducted by those working in the laboratory where they are located.

- Emergency Shower – a unit that cascades large volumes of water over the entire body.
- Eye Wash Station – a unit that flushes water specifically to the eyes.
- Eye/Face Wash Station – a unit capable of flushing both the eyes and the face.
- Drench Hose – a hand-held until that is intended to *supplement* the existing shower and eye wash units but ***does not*** replace them.
- Combination Units/Safety Stations – a combination unit that consists of both emergency shower and eye wash station.
- Hands-Free/Stay-Open Valve – a valve that opens and closes the water supply to the emergency units and stays open until it is manually turned off.

11.2 Installation Standards/Requirements

OSHA emergency shower and eye wash station requirements do not specify details about emergency shower functionality or location. OSHA refers to ANSI/ISEA Z358.1-2014 standard for guidance on emergency showers and eye wash stations.

UAB EH&S follows the American National Standard Institute (ANSI) standard for emergency eye wash and shower equipment performance and placement (ANSI Z358.1-2014) as the single criteria for minimum design and performance requirements for emergency eye wash and shower equipment. The ANSI standard details installation requirements for emergency showers and eye wash stations. *Note: Self-contained and personal units described in the ANSI standard are not approved as general use at UAB and will only be approved on an emergent, temporary basis.*

11.3 Location

The location of emergency safety showers must be in the same vicinity as the potential hazard requiring their use. There are requirements for the eye wash and emergency shower, which are to be maintained by the workers and occupants in the lab. Eye wash and emergency shower stations must be:

- Free from obstructions (on or beneath the unit, impeding their proper function)
- In a well-lit area
- Clear, visible and current signage so it is easy to find
- Must take NO LONGER than 10 seconds to reach it from the site of an incident where hazardous materials/chemicals are handled

General Standards for eye wash stations and safety showers

- One eyewash is required per laboratory or work area that uses materials that are hazardous to the eyes
    - However, travel distance shall not exceed 10 seconds (or approximately 25 feet) from any point within the laboratory or work area, according to the ANSI standard
- All units should deliver tepid, potable water
- The path of travel from the hazard to the unit shall be free of obstructions
- The unit should be designated by high visible signage and the sign should be visible from all areas served by that specific station
- The PI, director, manager or designee shall train employees on locations and proper use of the emergency stations within the laboratory
- The eye wash station must be flushed and inspected weekly by the person designated to do so by the PI
    - Evidence of weekly flush and inspection shall be provided in the form of a tag attached to the eyewash that is signed and dated each week upon inspection
    - Weekly testing ensures that the eye wash station is operational and the plumbing flushed to provide clean water in the event of an emergency

Laboratories are considered “high hazard” and may require additional eye wash stations. EH&S will make the final decision regarding the need for additional units.

11.4 Testing and Inspection of Eye Wash Stations

Weekly testing and flushing serves several purposes when it comes to maintaining eye wash stations. Weekly flush inspections should run for a minimum of 3 minutes.

Testing ensures:

- Stations are operating properly
- Keeps station free of clutter
- Prevents microbial growth in the plumbing

EH&&S holds laboratories responsible for activating the eye wash stations in their spaces and ensuring that:

- Access to the eye wash station and emergency shower are kept free of clutter
- The nozzle dust covers remain in place to prevent dust or particulate build up
    - If the dust covers are not kept on the eye wash nozzles, dust and other particulate matter can clog the nozzles and effect water flow
    - This could also result in dust or other particulates being forced into the eyes when the eye wash is used
- Laboratories post a test record log kept near the eye wash station that documents weekly testing and activation is occurring

For more details, refer to **Emergency Eyewash Testing**

During testing, inspect the following:

Test eye wash stations for compliance with ANSI Z358.1-2014 including:

- Testing the water flow to check for proper quantity, spray pattern and good water quality
- Ensure the unit is not obstructed
- Ensure that the station has a tempering valve
    - If no tempering valve, identify as a recommended repair in the inspection report
- Ensure valves are working properly
- Ensure signage is clearly posted
- Ensure the station is free of corrosion
- Ensure the nozzle dust covers pop off automatically when the eye wash is activated
- Check for controlled flow for both eyes simultaneously
    - Uneven flow to one eye or the other indicates a malfunction or simple blockage of the filters underneath the spray cup

Report any malfunctioning eye wash station and/or emergency shower to maintenance to have the unit repaired. If either the emergency shower or eye wash station is not working properly, post a **Do Not Use** sign on the station to alert others and contact maintenance immediately.

11.5 Emergency Showers

All areas that use hazardous chemicals or materials must have access to an emergency shower.

- Emergency showers must meet ANSI Z358.1-2014 standards
- Must deliver tepid, potable water
- The location of the shower shall be identified with a highly visible sign
    - The sign should be visible from all areas served by that equipment
- The PI or designated person shall train all lab workers on the location and proper use of the emergency shower
- At least one emergency shower must be located NO LONGER than 10 seconds away from the hazardous work area or anywhere hazardous materials are used
- No doorways should have to be crossed to reach an emergency shower

11.6 Flow Rate

Emergency shower flow rates must meet the need for sufficient flow of water to flush the affected area completely.

- Showers require a minimum continuous flow rate of 20 gallons per minute for at least 15 minutes
- Eye wash stations require a minimum continuous flow rate of 0.4 gallons per minute
- Combination eye and face wash units require a minimum continuous flow rate of 3 gallons per minute for at least 15 minutes

11.7 Water Temperature

Water temperature should be tepid to avoid causing further harm to the injured person. ANSI specifies the water temperature must be in the tepid range of 60 to 100 °F (16 to 38 °C).

11.8 Testing and Inspection of Emergency Safety Showers

The ANSI standard provides guidance for inspection of emergency showers, recommending that the plumbed emergency shower be activated regularly to flush and very proper operation. The guidance suggests more frequent testing and flushing, but at a minimum annually.

11.9 Testing and Inspection of Safety Showers

The ANSI standard recommends weekly activation testing and annual flow testing for both eye wash and emergency shower stations. Because of the logistics involved in activating the emergency showers, EH&S requires weekly activation of eye wash stations only. OSHA does not mandate any time requirements on activation of eye wash stations or emergency showers but follows the guidance from ANSI. While ANSI recommends more frequent activation, it is only required that activation and flow testing occur for emergency showers no less than annually.

Emergency showers are activated and flow tested annually by UAB maintenance.

11.9.1 Visual Inspection of the Unit

Prior to activation testing, to avoid possible injury, check for the following things:

- Corrosion
- Leaks
- Pipe damage
- Damage to the unit
- Ensure the shower is clean and free of obstructions
- Verify shower has been tested annually on the log or hang tag on the unit
- Verify the distance from the floor to the shower head is 82 inches
- Verify the distance from the floor to the handle is 69 inches

- If the handle is too high and cannot be adjusted lower, a strap or string can be tied to the handle to make it reachable

11.9.2 Activating the emergency shower

- Ensure that the water flow is continuous
- Estimate that the unit can maintain constant flow for 15 minutes
- The valve activator must stay on until manually turned off and must activate water flow in one second or less
- Water must flow out of all showerhead jets
- Observe the flow to ensure the unit can deliver not less than 20 gallons per minute
- Sanitize the unit by flushing by allowing it to flow until the water runs clear. This will clear out any rust, bacteria or other contaminants.

11.9.3 Flow Test

Annual flow test

- Measures the flow rate of the device. This test is conducted annually, following established procedures. Let the water run for one minute to collect at least 20 gallons (75.5 liters).
- Documentation ensures the appropriate tag is on all units with test dates and initials after completion of passing flow test.
- If the safety shower does not have a current tag or has any issues, please contact building maintenance.

11.10 Test Failure, Malfunctions & Deficiencies

Corrective actions must be performed when deficiencies are noted by any personnel at any time. Malfunctions or deficiencies noted during periodic activations, inspections or normal daily activities must be reported immediately to maintenance. Annual test failures must be corrected immediately.

If use of the equipment is not possible tag the unit out with a “DO NOT USE” tag. Malfunctions should be reported to maintenance and the PI.

11.11 Servicing and Maintenance

The ANSI standard also covers servicing and maintenance requirements for emergency showers and eye wash stations.

The standard states that in addition to weekly flushing, good maintenance practices also include validating the following at least once per year:

- Water temperature
- Flow rate
- Location
- Operation

This ensures the equipment is performing according to design and providing the appropriate level of emergency relief. Annual inspections certify that the emergency safety shower remains compliant with the ANSI requirements.

11.12 Signage

The location of all emergency equipment must be identified with a highly visible sign. Signs must be conspicuously posted using universal symbols or text that describes the installed equipment properly. Below are some current emergency shower and eye wash station signs you may see posted.

11.13 Using Emergency Showers and Eyewash Stations

Eyewash Station

1. Assist the victim to the unit, their vision may be impaired if chemicals splashed into eye
2. Activate the unit using the hands-free valve
3. Place the eyes in the stream of water
4. Hold the eyelids open with fingers if necessary
5. Remove contact lenses if used
6. Flush for a minimum of 15 minutes
7. Seek medical attention

Emergency Shower and Drench Hoses

1. Assist the victim to the shower. Do not let them slip and fall.
2. Activate the unit using the hands-free valve.
3. Put modesty aside. Remove any contaminated clothing first, if possible.
    a. Rinsing contaminated clothing will wash chemicals out of the clothing and onto the skin.
    b. If not possible prior to rinsing, remove contaminated clothing during the flushing process.
    c. Shield the victim using blankets or by closing the doors if necessary for privacy.
4. Flush for at least 15 minutes.
5. Seek medical attention if needed.

6. Provide alternate clothing (lab coats, scrubs, blankets, etc.) as necessary after decontamination.

Drains are often not installed under emergency showers. The lab must contact building maintenance immediately to stop the flow of water and clean the floor, to avoid flooding.

If you have any questions or need assistance with emergency eye wash or shower stations, please contact Environmental Health and Safety at **205-934-2487** or ChemicalSafety@uab.edu.

CHAPTER 12: INDOOR AIR QUALITY

Modern facilities are generally considered safe and healthy working environments. Air quality complaints are often of a subjective, nonspecific nature and are associated with periods of occupancy within a particular building. These symptoms often disappear when the employee leaves the workplace. They include headache, dizziness, nausea, tiredness, lack of concentration, eye, nose and throat irritation.

The information provided on the **EH&S website** can help to determine if a particular indoor environment is causing or exacerbating health related issues.

12.1 Common Indoor Air Quality Issues

12.1.1 Mold

If or when mold is discovered in an area, remediation may be required to eliminate the problem. If mold growth is discovered or suspected to be causing contamination in an area contact EH&S @ 205-934-2487 and visit the **EH&S website**.

12.1.2 Unexpected Odors

Chemical and related odors in an area often generate complaints of chemical exposure. Sometimes the odor is a new chemical or chemical vapors that have been released into the air. Sometimes the odor is a symptom of poor ventilation allowing a higher-than-normal buildup of a familiar material. Most common chemical contaminants that can create unpleasant odors are volatile organic compounds (VOCs) or dry drain traps. Some odors are considered health hazards and some are not. If you suspect chemical odors in your area, contact EH&S @ 205-934-2487 or visit the **EH&S website**.

12.2 Recommended Ventilation Rates

The American Society for Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) established recommended ventilation rates for indoor environments in 1973.

ASHRAE amended this standard in 1975 to specify the minimum value of 5 cubic feet per minute (CFM) of outdoor air per person be used in building design. This standard has been incorporated into the building codes of many cities and states.

The ASHRAE standard recommends a minimum of 5 CFM of outdoor air per person (0.06 CFM/sq ft) for offices and reception areas and 7.5 CFM per person (0.06 CFM/sq ft) for indoor spaces such as classrooms/lecture halls and laboratories.

The ASHRAE standard can be found here **Ventilation for Acceptable Indoor Air Quality**

12.3 Recommended Temperature and Humidity

Heating and cooling in every laboratory should be adequate for the comfort of the occupants and operations of the equipment present in the lab. According to ASHRAE, the comfortable range is defined

as 69-76 °F, at 35% relative humidity (RH) for winter months and 73-79 °F, at 60% RH for summer months. Indoor relative humidity should be kept below 60% to discourage mold growth. Temperatures above 76 °F have been associated with indoor air quality complaints, regardless of the relative humidity.

Never open windows or prop open doors in the summer for cooling, since open windows can alter the air balance in the laboratory. The use of space heaters is prohibited in laboratories, regardless of the season as they present a fire hazard. If there are concerns regarding the internal air quality, click **here** for more information.

12.4 Resources for Indoor Air Quality

EH&S has a few tips to prevent or remedy indoor air quality issues. As the occupants of the building generally have a greater working knowledge of the building space, the occupants are often the best at determining the source of an indoor-air-quality (IAQ) issue. If no obvious source is found, then EH&S can conduct some basic screenings to help track sources of odor or irritation.

Temperature and humidity can cause issues if they fall outside the range of comfort for the building occupants. If an area is too warm and/or too dry, occupants can suffer eye and respiratory irritation even when no chemical or biological agents are present. High humidity makes an area feel “muggy” and may contribute to mold growth.

IAQ issues can arise from a variety of conditions.

Questions to ask if there is a potential IAQ problem as soon as it is noticed:

- Has the area flooded or had moisture infiltration?
    - Bacteria and mold grow easily in damp carpeting, carpet pads and on sheetrock/drywall.
- Is there a kitchen or refrigerator present?
    - Cooking odors can be unpleasant. Small amounts of garbage in sink traps can smell bad and the drip pans of refrigerators can grow bacteria and mold. Make sure sinks and fridges are cleaned regularly.
- Is the area dusty?
    - Filing rooms and offices with large numbers of papers can attract and accumulate dust. Try to keep paper accumulation to a minimum and have areas dusted regularly.
- Are there any dry drain traps?
    - Drain traps becoming dry can cause foul odors that can present as the smell of hazardous chemical fumes.

Questions for potential sources of chemical irritants:

- Is there new paint, carpet or furniture in the area?
    - These can release low levels of irritating substances into the surrounding areas.
- Are there copiers or printers in the space?
    - Copiers can generate ozone and both copiers and printers can release toner dust.
    - 3D printers have the potential to produce noxious odors.

- Is there some type of chemical in use in neighboring spaces (including laboratories, darkrooms, copy rooms, and construction areas)?
    - Some chemicals, especially organic chemicals and bleach, can produce strong odors that can impact surrounding areas.
- Is there garbage or chemical residue in the trash cans?
    - Rotting fruit can smell similar to an organic solvent.
    - Paper towels wet with glues, paints or solvents can release vapors into the surrounding areas.
        - Shop towels or materials saturated with solvents or similar compounds should be disposed of in flammable rated waste cans.
- Are there any cleaning supplies or chemicals in the vicinity?
    - Cleaning supplies can release chemical vapors. Wax strippers used on tile floors can cause eye and respiratory irritation.
- Is an outdoor source of odor being brought in through the ventilation system?
    - Outside smells can range from cigarette smoke too close to an entrance or intake, to fertilizer being spread near a window, all of which can produce noxious odors.
- Is there an occupant wearing strong perfume/cologne/lotions/oils?
    - Some fragrances are unpleasant or irritating to anyone who may be sensitive to smells. Common sense and courtesy should be guidelines for wearing fragrances in the workplace.

12.5 Reporting an Indoor Air Quality Problem

To report an Internal Air Quality concern, issue or problem, contact EH&S @ 205-934-2487 or ChemicalSafety@uab.edu.

12.6 Environmental Monitoring

The UAB employee health program monitors employee exposure levels to any material or substance regulated by OSHA or the American Conference of Governmental Industrial Hygienists (ACGIH). Results of this testing may be compared to PELs, ACGIH Threshold Limit Values (TLVs), NIOSH Recommended Exposure Limits (RELs) or other applicable guidelines. For more information, visit the UAB employee health website, **UAB Employee Health**.

12.7 Routine Monitoring

Routine monitoring may be initiated under several conditions:

- If there is a reason to believe exposure levels exceed the designated action level.
    - Usually one-half of the PEL
- If a regulatory agency mandates routine monitoring.

- If a change in a procedure may significantly change an employee's exposure to a material or chemical.

If the action level is exceeded, corrective procedures will be required, and monitoring will be repeated periodically as required by the standard.

If the action level is *not* exceeded on either the initial or follow-up monitoring, monitoring may be discontinued as allowed by the standard.

Certain chemical agents are monitored on a scheduled basis. If a laboratory or department is using one of these chemical agents on a regular basis and is not scheduled for routine monitoring, please contact EH&S @ 205-934-2487 or ChemicalSafety@uab.edu.

Note: In clinical, hospital and animal care spaces, there may be separate or additional requirements for each of the topics covered herein.

For information on any of the other Industrial hygiene or environmental resources at UAB, please use the links below.

- **Water Monitoring**
- **Asbestos Removal Specifications**
- **Office Ergonomics Awareness**
- **Shop Safety**
- **Fire Safety**
- **Emergency Response Plan**
- **Evacuation Routes**

CHAPTER 13: FUME HOODS

13.1 Ventilation Rates

OSHA guidelines state four to twelve (4-12) room air changes per hour is adequate general ventilation if local exhaust systems such as hoods are in use. General laboratories using hazardous materials shall have a minimum of six (6) air changes per hour (ACH). Exhaust ventilation shall be continuous.

Environmental Health and Safety is available to conduct a risk assessment to confirm optimal ACH for specific areas and/or procedures.

Some laboratories may be able to go to four (4) ACH when unoccupied during non-working hours, but this must be assessed by the EH&S ventilation team. Consideration should be given not only to the current needs but also to the future, where the research may change. Future use of hazardous materials in the space will be restricted without adequate ventilation. Contact EH&S for a risk assessment or assistance with fume hood questions at 205-934-2487.

13.2 Duct Work

Fume hood duct work is generally constructed of stainless steel or G90 galvanized metal. Materials used in each exhaust system need to be consistent, compatible and in accordance with current regulations. Laboratory planners and HVAC engineers should collaborate with EH&S to discuss options prior to material selection. The volume of exhaust flow and velocity in each duct should be sufficient to move effluent quickly to prevent condensation or liquid or settling of solids on the duct walls. No laboratory ventilation system ductwork shall be internally insulated.

Laboratory chemical fume hoods are the most important safety equipment used in a laboratory to protect personnel from exposure to hazardous chemicals. Fume hoods are local ventilation devices used to limit exposure to hazardous fumes, vapors or dusts. Fume hood vents are separate from a building's heating ventilation and air conditioning (HVAC). The exhaust from fume hoods is not recirculated back into the building.

A laboratory ventilation system should include the following characteristics and practices:

- Heating and cooling should be adequate for the comfort of workers and operation of equipment.
- Local exhaust ventilation devices should be appropriate to the materials and operations in the laboratory.
- The air in laboratories should be continually replaced.
- Laboratory air should not be recirculated but exhausted directly outdoors.
    - May be required in some laboratories based on the nature of the work and materials used.
- Air pressure in the laboratory should be negative with respect to the rest of the building.
    - May be required in some laboratories based on the nature of the work and materials used.
- Ventilation systems should be inspected annually.

Additional information about indoor air quality can be found on the **EH&S Services page.**

13.3 Use of Chemical Fume Hoods

Fume hoods or other effective location ventilation must be provided and used when the materials used may exceed exposure limits in the laboratory. Before work begins, laboratory personnel should be provided with proper training that includes:

- How to use the ventilation equipment
- How to ensure it is functioning properly
- Consequences of improper use
- Steps to take in the event of
    - System Failure
    - Power Outage
    - Special circumstance causing impairment of function
- Importance of signage

EH&S provides an online training course to cover all these points and can be accessed online using the link provided. **BIO304 - Biosafety Cabinets & Fume Hoods**

13.4 Types of Fume Hoods

Bypass Hoods

- Air bypass hood incorporated above the sash
- Additional source of room air when closing sash

Auxiliary Air Hoods

- Attached duct dedicated to supply of outside air to the face of the bypass hood.
- Energy savings by reducing the amount of temperature-controlled air exhausted.

Variable Air Volume (VAV) Hoods

- Most sophisticated
- Require technically proficient
    - Design
    - Installation
    - Maintenance
- Unique ability to maintain a constant face velocity as sash height changes

Ductless Hoods

- Conventional hood design
- Self-contained to recirculate air back into the lab after filtration.
- Use HEPA or ACF filters to remove contaminants from hood air.
- Use is limited to nuisance vapors and dust that do not present fire or toxic hazard.

High-Performance Chemical Fume Hoods

- Operates with lower intake face velocity
- Use with chemicals or radiological agents
- Known as “low-flow chemical fume hoods”

13.5 Specialty Hoods

Walk-In Hoods

- Sits directly on the floor
- Very tall and deep chamber accommodating large pieces of equipment
- Designed as
    - Conventional
    - Bypass
    - Auxiliary Air
    - Variable Air Volume

Snorkelers

- Also known as
    - Elephant trunks
    - Flex ducts
- Designed to be mobile as it can be placed over specific areas as needed
- Generally used over/with
    - Gas Chromatographs
    - Vacuum pumps
    - Excimer lasers
    - Other equipment that produces hazardous air pollutants

Canopy Hoods

- Horizontal enclosures having an open central duct suspended above a workbench
- Used to exhaust areas too large to be enclosed within a fume hood
- Capture zone is only a few inches below the opening
- Best for capturing water vapor or heated air

Perchloric Acid

- Have wash-down capabilities to prevent buildup of explosive perchlorate salts within the exhaust systems.

Glove Boxes

Used in situations where the following pose too great of a risk to use a regular chemical fume hood:

- Toxicity

- Radioactivity
- Oxygen reactivity

The advantages to using a glove box is two-fold. Protection for both:

- Worker
- Product

Two commonly sought out specialty types of gloveboxes include:

- Radioisotope
    - Ideally made from welded stainless steel to ensure against the absorption of radioactive materials
    - Require a face velocity of 125 fpm

13.6 Hood Requirements and Considerations

13.6.1 Positioning

There are two major factors that affect the efficiency of a fume hood:

- Location
    - Persons walking by can cause turbulence and contaminants can be pulled into the hood.
    - The diffuser location can cause turbulence above the hood and cause contaminants to escape into the room.
- Air flow
    - All doors should remain closed to maintain negative pressure from the hallway
        - Ensures any contaminants in the lab will be exhausted through hood and not escape into the hall.
    - Face velocity is a measurement of the average velocity at which air is drawn through the face to the hood exhaust.

13.6.2 Alarms

Many of the newer variable air volume (VAV) hoods are installed with:

- Alarms
- Sensors
- Controls
- Gauges

Hoods will alarm for several reasons:

- The sash has been raised to a height at which the hood can no longer exhaust enough air
- The building air exhaust system is not working properly
- Power outage

If and/or when a hood alarms, no chemical work should be performed until the reason for the alarm has been fixed or remedied. Additionally, lab workers should not stop or disable hood alarms. If a hood is continually alarming, and a reason is not determined to rectify the issue, close the sash and contact maintenance to place a **work order**.

13.7 Manual Controllers

Chemical fume hoods with manual controllers should be set to the proper operating position before beginning work. Contact EH&S at 205-934-2487 or ChemicalSafety@uab.edu for assistance.

13.8 Safely Working in a Fume Hood

Environmental health and safety provides training and guidance on safe work practices in hoods, **BIO304 - Biosafety Cabinets & Fume Hoods**. Anyone planning to work with chemicals in a fume hood is required to complete the training course. While working in a fume hood, there are practices that should always be followed:

- Ensure the fume hood is working properly
  - Attach a small Kimwipe to the bottom lip of the sash. If the hood is operating properly, the Kimwipe will be pulled into the hood.
  - Test alarm functions on hood.
  - Never work in the hood if the alarms are not functioning properly.
- Perform work at least six inches back from the face of the hood.
- Prevent items from blocking the sash closure
  - Impedes air flow
- Keep the sash height at the level marked/labelled by the manufacturer
- Close the sash when not working in the fume hood
  - Sashes can be vertical, horizontal, or a combination of the two
- Work slowly
  - Reduces the creation of the eddy current, disrupting the containment ability of the hood
- Never stick your head, face or body into the fume hood
  - Does not protect you
- Never use a fume hood as a canopy hood
  - Do not use to remove heat
  - Disrupts airflow
- Never overpack a fume hood
  - Prevents air from flowing around the objects
- Never store chemicals in a fume hood
  - Prevents hood from being used for its intended and designed purpose
  - Chemicals that require vented storage should be stored in vented chemically-graded cabinets
- Should not use fume hood as satellite accumulation area for waste

    - Prevents hood from being used for its intended and designed purpose
- Always wear appropriate PPE, at a minimum:
    - Wear the proper work clothes
    - Don a clean, buttoned lab coat
    - Shoes that cover the entire foot
    - Long pants
    - Long sleeves (if lab coat does not come all the way to wrists)
    - Always use appropriate eye protection
    - Wear a full-face shield if there is a possibility of eruption or explosion.
- Always keep the hood surface free of
    - Stored chemicals
    - Chemical waste
    - Kimwipes/paper towels
    - Lab utensils/materials/equipment
        - Materials and equipment should be organized and out of the immediate workspace as not to cause additional hazards from clutter.
- Always place instruments two inches above the hood surface to allow air flow under the instrument.
- Never place items at the very back of the hood that will block air flow to the baffle
- Never use hood for evaporation of chemicals
- Never allow objects to be pulled up into the exhaust ducts
- Chemical hoods should be maintained, monitored and routinely tested for proper performance.
    - Annual testing and certification is provided by UAB
        - Contact EH&S if hood has not been certified in the past 12 months.
    - Ensuring proper function of the hood should be performed before any work is conducted in the hood.
- When work is complete in the hood
    - Remove all chemicals
    - Close the hood sash to appropriate height

13.9 Cleaning a Fume Hood

Chemical fume hoods require regular cleaning to ensure the safety of all users. Clean the following periodically by wiping down with mild soapy water and rinsing with water and finally with isopropyl alcohol:

- Interior surfaces
- Exterior surfaces
- Sash

Spills should be cleaned up immediately and debris/materials should be disposed of as hazardous waste. All laboratory personnel should wear appropriate PPE when cleaning the fume hood to prevent chemical exposures.

13.10 Fume Hood Certification

Chemical fume hood certification is necessary to ensure that the hoods are performing adequately to remove hazardous chemical vapors and fumes. Fume hoods must be certified annually through EH&S. Fume hoods are certified by EH&S and a new certification label will be placed on the hood with the date tested and the expiry date. Any materials that may obstruct airflow should be removed prior to certification.

The acceptable range of the average face velocity is 80-100 feet per minute (fpm). Specialty hoods may require a different range.

13.11 Testing

13.11.1 Periodic Fume Hood Testing

Regular performance testing should be conducted to ensure its proper operation prior to working with any hazardous materials. The hood must then be serviced to repair the flow and recertified prior to the hood being released for use. Because fume hoods are considered part of the building, they are performed by qualified technicians at UAB. There is no charge for the annual certification.

13.11.2 Fume Hood Tracer Gas Testing

The benchmark velocity for fume hoods is established by ANSI. All new fume hood installations require As Installed (AI) testing. Older hoods require As Used (AU) testing. Must meet all as-installed ANSI testing requirements.

13.11.3 Out of Service Notice

When a fume hood is taken out of service for any reason, a “Restricted Out-of-Service Notice should be placed on the hood. Do not remove any “Out-of-Service” tags. This posting is there for the health and safety of all laboratory personnel. Once UAB maintenance has completed repairs, EH&S will retest the hood and release it back to service, if it meets the acceptance criteria for certification.

13.12 Installation of New Fume Hoods

Improper installation of new fume hoods or other capture devices has the potential to negatively impact the existing ventilation system of:

- The room
- Other capture devices
- Ventilation system of the entire building

Careful planning and knowledge of the existing building ventilation systems is required to avoid any undesirable consequences of new installations. All new chemical fume hoods and other capture devices

must be installed in consultation with EH&S. After installation, all new and any relocated fume hoods must be inspected and certified by EH&S before officially certifying and commissioning.

Environmental Health and Safety can provide consultation on selection, installation and commissioning of fume hoods, laminar flow clean benches, ductless fume hoods and other capture devices that can remove hazardous vapors and gases from the work area.

13.13 Decommissioning or Removal of Fume Hoods

Replacing a fume hood requires consultation with EH&S. Older fume hoods could contain asbestos inside the fume hood, and in the insulation of the duct work. Any asbestos must be safely removed and disposed of by a certified asbestos removal company. Fume hoods also require decontamination before any decommissioning and any repair work.

CHAPTER 14: CHEMICAL STORAGE

Storing chemicals properly is as important as using them properly. Chemicals cannot be stored just anywhere in the laboratory. Certain classes of chemicals need to be stored in a safer location than just out on the shelf with general chemical storage. Segregating chemicals properly ensures that chemicals that are incompatible do not create a hazard for those working in the laboratory. Chemicals need to be stored according to their hazard classes and not in alphabetical order.

Listed below are the basic classes of chemicals that should be stored according to their hazard:

- Acids
    - Examples:
        - Inorganic Acids
            - Hydrochloric acid (HCl)
            - Nitric acid (HNO_3)
            - Perchloric acid ($HClO_4$)
            - Etc.
        - Organic Acids
            - Formic Acid
            - Acetic Acid
            - Propionic Acid
        - Organic and Inorganic acids *should not be* stored together as adverse chemical reactions can occur between the two.

Below are the most common GHS pictograms for acids. Some acids have additional hazards, but these are the most common. Always review the SDS for that acid for storage and incompatibilities, etc.

- Bases
    - Examples:
        - Sodium Hydroxide (NaOH)
        - Ammonium Hydroxide (NH_4OH)
        - Sodium Bicarbonate ($NaHCO_3$)
        - Etc.

Below are the most common GHS pictograms for bases. Some bases have additional hazards, but these are the most common. Always review the SDS for that base for storage and incompatibilities, etc.

- Oxidizers
    - Hydrogen peroxide
    - Azides
    - Halogens
    - Chlorine containing compounds
    - Etc.

Below is the GHS pictogram for oxidizers. Some oxidizers may have additional hazards, but this is the most common. Always review the SDS for that chemical for storage and incompatibilities, etc.

- Flammables
    - Organic solvents
    - Alcohols
    - Etc.

Below is the GHS pictogram for flammable chemicals. Some flammable chemicals may have additional hazards, but this is the most common. Flammable chemicals should be stored in a flammable cabinet. Always review the SDS for that chemical for storage and incompatibilities, etc.

Acids and flammables should ***not*** be stored together.

Acids and bases should ***not*** be stored together.

Acids and oxidizers should ***not*** be stored together.

Oxidizers and flammables should ***not*** be stored together.

14.1 Acid Storage

Acids should *not* be stored in wood or porous storage cabinets. Acid cabinets are readily available and come in a variety of sizes to fit the needs of the laboratory.

EH&S has a list of **Chemicals That Should NOT Be Stored Together.**

Storing incompatible chemicals too close together can create a dangerous fire, explosion or toxic fume release. OSHA provides a list of five (5) common chemicals and their incompatible counterparts for a quick reference:

- Water (H_2O) – Incompatible with many chemicals, including but not limited to:
  - Acetyl chloride (CH_3COCl)
  - Chromic acid – (H_2CrO_4)
  - Sulfuric acid – (H_2SO_4)
  - Sulfur trioxide – (SO_3)
- Nitric Acid (HNO_3)– Commonly used in fertilizers and explosive; incompatible with:
  - Acetone ($(CH_3)_2CO$
  - Acetic acid (CH_3COOH)
  - Alcohols (R-OH)
  - Chromic acid (H_2CrO_4)
  - Aniline ($C_6H_5NH_2$)
  - Hydrocyanic acid (HCN)
  - Hydrogen sulfide (H_2S)
  - Flammable substances
- Zinc Powder (Zn)– When used as an ingredient in paint, cosmetics and batteries; incompatible with:
  - Sulfur
- Oxygen (O_2)– is incompatible with:
  - Hydrogen (H_2)
  - Flammable substances
  - Oils
  - Grease
- Chlorine (Cl^-) – is incompatible with:
  - Ammonia (NH_3)
  - Acetylene (C_2H_2)
  - Benzene (C_6H_6)
  - Butadiene (C_4H_6)
  - Hydrogen (H_2)
  - Petroleum gases (C_3H_8)
  - Sodium carbide (C_2Na_2)
  - Turpentine ($C_{10}H_{16}$)

Additional information about OSHA chemical storage, including details about incompatible chemical storage, are available on their **Safety Data Sheets.**

Adverse events that may occur because of reactions between incompatible materials include fire, explosion, violent chemical reactions, and/or release of toxic fumes/gases.

14.2 Recommendations for Storage Areas

Laboratory shelves should have a raised lip along the outer edge to prevent containers from falling. Never allow chemical containers to extend over the edge of the shelf. Liquids, corrosives and oxidizers should *not* be stored on shelves above eye level.

Here are some other categories to consider for properly segregating and storing chemicals:

- Separate solids from liquids
    - Separate metals from non-metals
        - Keep metals away from water and moisture to prevent corrosion or reaction
- Separate non-hazardous from hazardous
    - Use GHS hazard symbols for quick categorizing
- Separate toxic from irritants (non-hazardous)
    - Use GHS hazard symbols
- Separate flammable liquids (or solids) from all other hazardous chemicals
- Separate oxidizers from other hazardous chemicals
    - Must be stored at or below eye level.
    - Generally, should be stored in secondary containment.
    - Some need to be stored in explosion-proof cabinets due to their reactivity.

14.3 OSHA Chemical Storage Safety Requirements

- Improperly transporting or storing chemicals can cause injuries. According to OSHA guidelines, workers should be aware of unsafe practices, such as improper handling and unhealthy situations. Hazardous chemicals pose health and safety risks even when workers are not transporting them. **OSHA Chemical Storage Requirements** include the following basic legal guidelines:
    - Employees and lab workers must receive a written plan and training sessions to work with chemicals.
    - Chemicals must be accompanied by a Safety Data Sheet (SDS).
    - SDS must be readily available

OSHA recommends workers follow certain steps to prevent hazards when storing chemicals:

- Keep storage areas free from clutter, combustible materials, explosives and flammable conditions.
- Prevent chemical storage conditions that may encourage rats or pests.
- Place stored materials at least six (6) feet from lifts or elevators.
- Separate chemicals that cannot be stored together.

OSHA provides additional resources for chemical storage, secondary containment and compliance. Resources can be found in the links below.

What is Secondary Containment?

Spill Prevention, Control, and Countermeasure (SPCC) Plans

How to Stay Compliant with Federal Regulations

EH&S is available to help assist in chemical inventory and development of a storage plan for chemicals in the laboratory.

Contact EH&S for additional resources or information 205-934-2487.

14.4 Flammable and Combustible Liquids in Laboratories

Flammable and combustible liquids are liquids that can burn. They are classified as flammable or combustible based on their flashpoint. The flashpoint of a flammable liquid is the lowest temperature at which it can form an ignitable mixture with air and produce a flame when a source of ignition is present.

Flammable liquids are chemicals that have a flash point below 37.8 °C (100 °F) and combustible liquids have a flashpoint at or above 37.8 °C (100 °F) and below 93.3 °C (200 °F). Flammable liquids will ignite (catch on fire) and burn easily at normal working temperatures when compared to combustible liquids. The National Fire Protection Agency (NFPA) classifies flammable liquids based on the flashpoint or boiling point, **table 14.1**.

The most obvious harm of flammable and combustible materials is the danger of a fire or explosion. There are other properties of these liquids that may be hazardous. Flammable and combustible liquids can cause health problems depending on the specific material and route of exposure (breathing the vapor/mist, eye or skin contact or swallowing). Safety data sheets (SDS) and the supplier's labels on the container describe the hazards of the flammable or combustible chemical.

Table 14.1 NFPA and IBC Classification of Flammable and Combustible Liquids

Type	Class	Flashpoint	Boiling Point
Flammable	IA	< 73°F	< 100 °F
	IB	< 73°F	> 100 °F
	IC	≥ 73 °F and <100 °F	
Combustible	II	≥ 100 °F and <140 °F	
	IIIA	≥ 140 °F and <200 °F	
	IIIB	≥ 200 °F	

14.5 Training

It is the responsibility of the PI/laboratory supervisor to ensure that personnel using flammable or combustible liquids have documented chemical safety training (**CS101 - Chemical Safety**).

14.6 Purchasing

Containers for flammable and combustible liquids shall not exceed the maximum capacities listed in the OSHA standard and NFPA45/55, **table 14.2**. Follow the size limitations for container to prevent ignition of flammable liquids by sparks from static discharge during pouring operations.

Table 14.2 Maximum Capacity of Containers for Flammable and Combustible Liquids

	Flammable Liquid			Combustible Liquids	
	*Class IA	Class IB	Class IC	Class II	Class III
Glass/Approved Plastic	1 pt	1 qt	1.1 gal	1.1 gal	5 gal
Metal	1.1 gal	5 gal	5 gal	5 gal	5 gal
Safety Cans	2.6 gal	5 gal	5 gal	5 gal	5 gal

*Glass containers as large as one (1) gallon shall be permitted to be used with special approval from EH&S if needed. If the required purity would be adversely affected by storage in a metal or an approved plastic container, or if the liquid would cause excessive corrosion or degradation of a metal or approved plastic container.

14.7 Hazard Communication

Each laboratory should conduct a hazard assessment for work involving flammable liquids and the assessment should address the following:

- Proper use and handling
- Fire safety
- Fire Extinguisher located within 75 feet of approximate location of work
- Chemical toxicity
- Storage
- Spill response

A hazard assessment should be conducted when:

- A new procedure or experimental work is to be performed.
- Scaling up of any previously approved flammable liquid to more than ten (10) times of the original volume.
- A highly flammable solvent such as diethyl ether or hexane is used for the first time.

14.8 Flammable Storage

Based on NFPA 45, the maximum amount of flammable/combustible liquid allowed (including "in use" and stored inside flammable cabinets) in a Class D laboratory is 150 gallons or 2 gallons/100 ft^2, more information can be found in **table 14.3**.

Table 14.3 NFPA 45 Liquid Storage Quantity Limits

Fire Hazard Class	Material Class	Maximum Quantity in Use (gal)		Maximum Quantity in Use and Storage (gal)	
		Per 100 ft^2	Per Laboratory	Per 100 ft^2	Per Laboratory
A – High Fire Hazard	I	10	480	20	480
	I, II, IIA	20	800	40	1,600
B – Moderate Fire Hazard	I	5	300	10	480
	I, II, IIA	10	400	20	800
C – Low Fire Hazard	I	2	150	4	300
	I, II, IIA	4	200	8	400
D – Minimal Fire Hazard	I	1	75	2	150
	I, II, IIA	1	75	2	150

*Material Class I encompasses Class IA, IB, and IC materials. NFPA 45 does not place limits on Class IIIB materials.

The amount of flammable or combustible liquid that can be stored safely is listed in **table 14.4.** The quantities are based on class and the floor on which the laboratory is located. All laboratories on UAB's campus are class D laboratories.

In addition, instructional laboratories are not allowed to store large quantities of flammable liquids (> 10 gallons). The allowable limit in instructional laboratories is the minimum amount required to perform daily activities. Additional chemicals can be stored in a separate preparation laboratory.

Table 14.4 NFPA Maximum Allowable Storage Quantities – Above 3rd Floor				
Floor	Laboratory Fire Hazard Classification			
	Class A	Class B	Class C	Class D
1	100%	100%	100%	100%
2	100%	100%	100%	100%
3	100%	100%	100%	100%
4	Not Permitted	50%	75%	75%
5	Not Permitted	50%	75%	75%
6	Not Permitted	50%	75%	75%
7-9	Not Permitted	Not Permitted	50%	50%
>9	Not Permitted	Not Permitted	50%	50%

Additional requirements for flammable storage in laboratories are as follows:

- Minimize the amount of flammable liquids in the laboratory.
- Buy only the amount that will be used completely and in the immediate future.
- Buy the smallest available containers for the amount required.
- If the building has a flammable storage room with a fire suppression system, store flammable materials there until they are needed.
    - Only transport the amount needed for that day/experiment.
- Laboratories using flammable liquids in quantities **greater than 10 gallons** should store them in an approved flammable liquid storage cabinet (FLSC).
- FLSCs are not intended for the storage of highly toxic materials, acids, bases, compressed gases or pyrophoric chemicals.
- Never store incompatible materials like oxidizers, acids etc. together with flammable liquids.
- ***No chemicals should be stored in the fume hood***.
- Flammable Liquid Storage Containers (FLSC) must be:
    - In good condition
    - Doors must be closed and latched.
    - Must be marked with “Flammable-Keep Fire Away”.

- The maximum quantity of flammable liquids in each laboratory depends on the storage configuration:
    - Glass, metal or plastic
        - 10 gallons (38 liters)
    - Safety cans
        - 25 gallons (95 liters)
    - Flammable liquid storage cabinets
        - 180 gallons (684 liters)

- On the bench top, limit the storage of flammable liquids to those in immediate use.
- Storage of flammables in laboratory refrigerators or freezers:
    - Is prohibited because electrical sparks from a conventional refrigerator can ignite the flammable vapors that build up inside.
    - Only approved flammable storage refrigerators may be used.
    - Conventional refrigerators in laboratories must be labelled with “NO FLAMMABLES”
    - NEVER store flammable solvents in walk-in cold rooms.
        - Cold rooms are not vented, flammable vapors can accumulate to dangerous levels that could cause an explosion.
- ***Do not store flammable liquids in chemical fume hoods***.

14.9 Working with Flammable Liquids

- Handle flammable chemicals in areas free from ignition sources and other combustible materials.
- Never heat flammable chemicals with:
    - Open flame
    - Oil bath
    - Heating mantle
    - Hot air bath
    - Microwave
- Do not allow flammable liquid containers in proximity to:
    - Heating mantles
    - Hot plates
    - Torches
- Safe methods for heating flammable
- Work that may involve the following risks, during work with flammable liquids should be restricted to the chemical fume hood with the sash at its lowest workable height:
    - Splashes
    - Highly exothermic reaction
    - Explosion
- All work with flammable liquids is to be performed in a chemical fume hood if possible.
    - Any work requiring 500 mL or greater must be done in a fume hood.
- Vacuum work involving flammable liquids must be conducted in a fume hood or isolated in a safe and acceptable manner.
    - Mechanical vacuum pumps must be protected using cold traps where appropriate.
    - The exhaust for the pump must be vented into an exhausting hood.
- Always use secondary containment to avoid any spills.

14.10 Personal Protective Equipment

The following standard laboratory PPE should be worn when there is a significant risk for splash of flammable liquids:

- Splash proof goggles
- Lab coat
- Closed-toed and closed-back shoes
- Nitrile gloves

If working with a higher hazard flammable liquid, specialized PPE is recommended:

- Fire resistant lab coats
- Heat resistant gloves

EH&S is available for consultation in selecting appropriate PPE or to provide assistance in developing a safety plan for working with flammable liquids. Please contact EH&S for assistance at 205-934-2487.

14.11 Chemical Inventory

UAB Environmental Health and Safety has a tool available to every PI and laboratory worker for managing chemical inventory. One of the functions of EHSA is chemical management. Visit the EHSA page to register a PI and laboratory workers. All laboratories will need to have an account in EHSA to manage chemical inventory as well as manifest hazardous waste.

The EHSA Handbook provides instructions on navigating and utilizing the system to perform various tasks. Additional resources include a built-in help button and directions for contacting EH&S for assistance. Before creating a profile in EHSA, the EHSA Orientation video should be viewed. For assistance in registering with EHSA or other inquiries, email EHSASupport@uab.edu or contact EH&S at 205-934-2487.

CHAPTER 15: PEROXIDE FORMERS

Peroxide-forming chemicals are a class of compounds that could form shock-sensitive explosive crystals. Many organic solvents common in laboratories are in a class of chemicals known as peroxide formers.

15.1 Safe Handling of Peroxide Formers

There are several compounds/elements that can react with oxygen in the air and form explosive peroxides upon *prolonged* storage. Peroxide formation in this group of chemicals may be accelerated if they are exposed to:

- Light
- Air
- Heat

Unstable peroxides formed in chemicals may detonate with extreme violence when concentrated by evaporation or distillation.

These chemicals may also explode:

- Upon contact or mixing with other compounds.
- By producing detonable peroxides.
- Upon being disturbed by:
    - Heat
    - Shock
    - Friction

While ether is the most common chemical to present this risk, other common solvents, such as isopropanol, have exploded upon distillation due to peroxide concentration. Peroxide forming chemicals can be divided into three (3) hazard classes based on the route of peroxide formation, **Table 15.1**.

A quick reference document can be found here **Working With Peroxide Formers.**

15.2 Common Classes of Peroxide Formers

- Ethers, acetals and ketals:
    - Cyclic ethers
    - Any with 1° or 2° alkyl groups
- Aldehydes:
    - Acetaldehyde
    - Benzaldehyde
- Compounds containing benzylic hydrogens:
    - Ethyl benzene
    - Benzyl Alcohol
- Compounds containing allylic hydrogens:
    - 1,4 Pentadiene
    - Allyl Alcohol

15.3 Three Hazard Classes of Peroxide Formers

15.3.1 Class A: Peroxide Hazard on Storage – Without Concentration

- Form peroxides that are difficult to detect or eliminate.
- Should be labeled with:
  - Date of receipt
  - Date of opening
- Dispose of **3 months** after opening.
- Dispose of **18 months** if unopened.

15.3.2 Class B: Hazard Due to Peroxide Concentration

- Can undergo explosive polymerization initiated by dissolved oxygen.
- Should be labeled with:
  - Date of receipt
  - Date of opening
- Dispose of **12 months** after opening
- Dispose of **2 years** if unopened
- Alcohols used that do not stress the peroxidizable material do not need to be tested for peroxidation and may be kept for longer duration.
- Actions that potentially stress the peroxidizable material include:
  - Heating
  - Chemical Reaction
  - Bulk Evaporation

15.3.3 Class C: Auto Polymerize as a Result of Peroxide Accumulation

- May explode when relatively small quantities of peroxides are formed.
- Normally have an inhibitor added (by the manufacturer) to prevent peroxide formation.
- Should be labeled with:
  - Date of receipt
  - Date of opening
- Dispose of **2 years** (if inhibitor added)
- Dispose of ***within 24 hours*** (if no inhibitor added)

Table 15.1. lists chemicals by the classes described above. For more information or assistance with peroxidizable chemicals, please contact EH&S at 205-934-2487 or ChemicalSafety@uab.edu.

Table 15.1. Classes of Peroxide Formers

Class A	Class B	Class C
Butadiene	Acetal	Acrylic acid
Chloroprene	Acetaldehyde	Acrylonitrile
Divinylacetylene	Benzyl Alcohol	Butadiene
Isopropyl ether	2-Butanol	Chloroprene
Potassium Amide	Cumene	Chlorotrifluoroethylene
Sodium Amide	Cyclohexanol	Methyl Methacrylate
Potassium Metal	2-Cyclohexen-1-ol	Styrene
Tetrafluoroethylene	Cyclohexane	Tetrafluoroethylene
Vinylidene Chloride	Decahydronaphthalene	Vinyl acetate
-	Diacetylene	Vinyl acetylene
-	Dicyclopentadiene	Vinyl Chloride
-	Diethyl ether (Ethyl Ether)	Vinyl Pyridine
-	Diethylene glycol dimethyl ether (diglyme)	Vinylidene Chloride
-	Dioxanes	-
-	Ethylene glycol dimethyl ether (glyme)	-
-	4-Heptanol	-
-	2-Hexanol	-
-	Methylacetylene	-
-	3-Methly-1-butanol	-
-	Methyl Cyclopentane	-
-	Methyl isobutyl ketone	-
-	4-Methly-2-pentanol	-
-	2-Pentanol	-
-	4-Penten-1-ol	-
-	1-Phenylethanol	-
-	2-Phenylethanol	-
-	2-Propanol*	-
-	Tetrahydrofuran (THF)	-
-	Tetrahydronaphthalene	-
-	Vinyl ethers	-
-	Other 2° alcohols	-

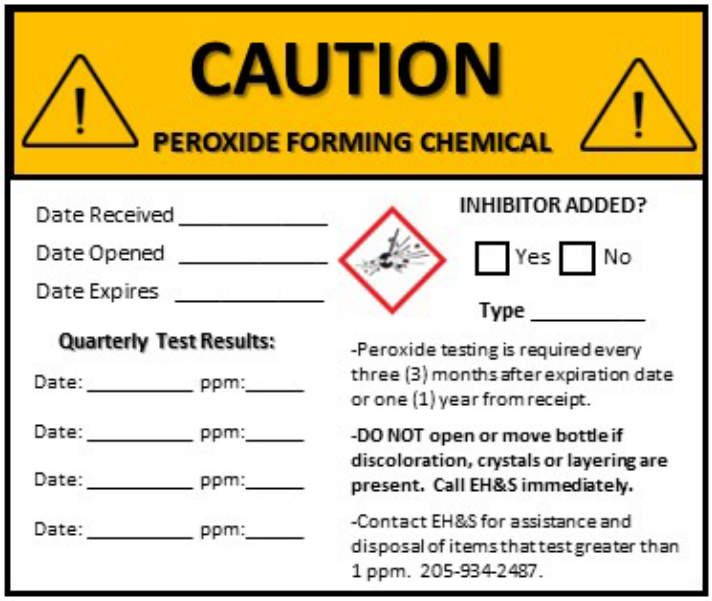
***2-Propanol (Isopropanol; Isopropyl alcohol, IPA) *need* to be tested if being distilled or otherwise concentrated. IPA used for cleaning or in cold rotovap fingers does not need to be tested.**

15.4 Control Measures for Working with Peroxide Formers

15.4.1 Purchasing

- Restrict the purchase of peroxide formers to quantities just enough for the planned work.
    - Ensure the chemical is used completely (before it begins to form peroxides)
- Restrict the purchase of ethers to containers not larger than 1 liter.
- Limit the stock of any such chemicals to three month's supply or less.
    - Test with peroxide strips regularly and never keep past manufacturer expiry date.
    - Dispose of remaining stock through hazardous waste before expiry date

- Peroxidizable chemicals must be dated upon receipt and upon first opening.
    - A printable label is available below.



15.4.2 Storage

- The quantity of peroxide-forming chemicals should be kept to the minimum amount needed.
- Store peroxide-formers in airtight containers away from:
    - Light
    - Heat
    - Oxidizers
    - Oxidizing acids
- The chemical should be stored in original container from manufacturer.
- Avoid using ground glass stoppers.
- Always follow manufacturer's recommendations.
- A list of peroxide formers that should be kept under nitrogen (if possible) can be found in Table 1, Class A.
- Test for peroxide formation at least quarterly, but more frequently if manufacturer recommends.
- Indicators of peroxide formation include:
    - Crystallization (usually around the cap)
    - Discoloration (yellow to brown)
    - Stratification (long sharp crystals forming on the bottom, or distinct layers forming – hair like appearance)
    - ***If any of these are observed, do not move the container and call EH&S immediately at 205-917-4766.***

15.5 Handling and Use

Test for the presence of peroxides before distilling/heating any peroxide forming chemical. A peroxidizable chemical should not be distilled/heated if it contains more than 80 ppm of peroxide. Most explosions of peroxide forming chemicals occur when a material is heated to dryness. Leave at least 10-20% liquid in the bottom. There are reports to indicate the formation of peroxide in tetrahydrofuran (THF) after three (3) days and in ethyl ether after 8 days of the distillation. Distillations should be:

- Stirred with a mechanical stirrer
- OR bubbling inert gas

DO NOT OPEN a container of peroxide-former chemical that has *obvious* crystal formation. Friction caused from opening the lid can cause an explosion.

DO NOT HANDLE the container OR force the lid open. Treat as potentially explosive and call EH&S immediately at 205-917-4766.

15.6 Evaluating and Testing for Peroxides

15.6.1 Examine for Visible Crystals

Old containers or those of unknown age of peroxidizable chemicals must be handled with great caution. Any peroxidizable chemical with *visible* discoloration, crystal formation or layering should be treated as potentially explosive. Peroxide crystals tend to form on the inner surfaces of the container. Solvents stored in glass bottles can be visually inspected for peroxides. Bottles containing organic solvents are typically made of amber glass, so a flashlight can be used to illuminate the interior of the bottle. Use caution when performing a visual inspection, peroxide formation may be present anywhere in the bottle. Peroxide crystal formation can occur on any surface of the bottle. A few examples are shown in **table 15.2.**

If no crystals are observed, proceed to the next step. If you observe viscous liquid or crystalline solids, do not move or handle the chemical any further. The crystals have the potential to cause an explosion if subjected to impact or friction. Immediately contact EH&S at 205-917-4766.

Table 15.2. Examples of Peroxide Crystal Formation on Chemical Containers

Location on Container	Example
Bottom	 
Side	
Threads	 
Outside	

15.7 Is it Safe to Test for Peroxides

- Safe to test if:
    - The history of the chemical is known and it is one of the following:
        - Chemicals with low peroxide hazard
            - Container has been opened:
                - Less than one (1) year old
        - Container is unopened:
            - Less than two (2) years old (date of receipt)
        - Chemicals with medium peroxide hazard
            - Container has been opened:
                - Less than six (6) months old
            - Container is unopened:
                - Less than two (2) years old (date of receipt)
        - Chemicals with high peroxide hazard
            - Container has been opened:
                - Less than three (3) months old
            - Container is unopened:
                - Less than one (1) year old (date of receipt)
    - Unopened bottles should be handled:
        - In a certified fume hood in the laboratory with:
            - Protective blast shield
            - Secondary containment

        - By personnel donning:
            - Chemical safety goggles (not glasses)
            - Face shield
            - Heavy gloves
            - Rubber apron
        - Test the chemical with the least possible disturbance, using colorimetric peroxide test strips.
- Not safe to test if:
    - The container volume has evaporated to *less than 10%* of the original volume.
    - **If the chemical is not safe to be tested** (via the criteria listed above), call EH&S at 205-917-4766.

15.8 Testing for Peroxide Formation

15.8.1 Peroxide Detection

There are a variety of methods available to test for the presence of peroxides in organic solvents. The most common and convenient is listed below:

- Test with colorimetric commercial test strips:
    - Commercial test strips have a test range of approximately 0.5 to 100 ppm and 100 to 1000 ppm.
    - If the peroxide value is less than 80 ppm, the chemical is safe to use
    - If the peroxide value for the strip 0.5-100 ppm tests at 100 ppm:
        - Test with the 100-1000 ppm strips to determine more accurate value.
        - Chemical is not safe to use:
            - Call EH&S for disposal at 205-917-4766.

15.9 Management and Disposal of Old Bottles/Containers

- Older bottles of peroxidizable chemicals must be handled very carefully and should never be opened by laboratory personnel.
    - Or bottles of unknown age.
- Any peroxidizable chemical should be treated as potentially explosive if it has visible:
    - Discoloration
    - Crystallization
    - Liquid Stratification
- Any container with more than 80 ppm peroxide could be explosive.
- Older steel containers that have *visible* rust may also be extremely dangerous.
- Do not attempt to move or open the container of a peroxidizable chemical if the age is unknown.
- Call EH&S to dispose of the chemical safely at 205-917-4766.

CHAPTER 16: WORKING SAFELY with NANOMATERIALS

The field of nanomaterials research is a growing field with many avenues for biomedical research and application. Although the risks of nanomaterials to human health and the environment are relatively unknown, it is important know and understand the recommendations for handling nanomaterials from NIOSH and other sources.

16.1 Nanomaterials

- Materials or particles with any external dimension in the nanometer (nm) scale
  - 1 nm – 100 nm
- Materials having internal or surface structures in the nanometer scale
- Particles that are naturally occurring or are incidental byproducts of combustion processes
- Particles that are engineered and designed with very specific properties related to
  - Shape
  - Size
  - Surface
  - Chemistry
- Unbound engineered nanoparticles
  - Under standard temperature and pressure (STP) are not contained in a matrix
  - Are a potential source of exposure

16.2 Types of Nanoparticles

Table 16.1. Types of Nanoparticles

Type	Example
Carbonaceous	Carbon Nanotubes, Fullerenes (buckeyballs)
Metal and Metal Oxides	Titanium Oxide, Zinc Oxide, Cerium Oxide, Aluminum Oxide, Iron Oxide, Silver, Gold, Zero Valent Iron
Semi-Conductor Devices	Quantum dots: Zinc-Selenide, Zinc-Sulfide, Cadmium-Sulfide, Cadmium-Selenide, Gallium-Arsenide, Lead-Selenide, Lead-Sulfide
Polymers	Polymer Nanoparticles (nanospheres and nanocapsules), polymer nanofibers

16.3 Current Occupational Exposure Limits

There are only a few occupational exposure limits specifically for nanomaterials. Some of the specific exposure limits recommended by OSHA are:

- Worker exposure to respirable carbon nanotubes and carbon nanofibers should *not exceed* 1.0 micrograms per cubic meter ($\mu g/m^3$) based on a NIOSH eight (8) hour TWA and REL.
- Worker exposure to nanoscale particles of TiO_2 should *not exceed* the NIOSH REL of 0.3 milligrams per cubic meter (mg/m^3)

Because exposure limits for other nanomaterials do not yet exist, PIs should minimize laboratory workers' exposure by using hazard control measures/engineering controls to protect from potential health and safety hazards.

16.4 Potential Hazards

- Inhaled nanomaterials may deposit in respiratory tract
- May penetrate cell membranes and cause damage to intracellular structures and functions.
- May be pyrophoric or readily combustible due to their size and surface area
- Exposures to nanomaterials may occur through
    - Inhalation
        - Greatest exposure hazard
    - Dermal contact
    - Accidental injection
    - Ingestion

16.5 Control Measures

16.5.1 Engineering Controls

- If working with dry/powder nanoparticles, work only in ventilated enclosures
    - Glovebox
    - Certified fume hood
    - Certified biosafety cabinet
- Where enclosures are not available, provide local exhaust ventilation
    - Capture hoods
    - Enclosing hoods

Ensure all are equipped with HEPA filters and designed to capture the contaminant at the point of generation or release.

16.5.2 Administrative Controls

- Always wash hands immediately after working with nanomaterials and before leaving the laboratory
- Develop cleanup and decontamination procedures for spills to minimize exposure
- Develop standard operating procedures to ensure proper training of laboratory personnel

16.5.3 Standard Operating Procedures

- Any work with nanomaterials requires a standard operating procedure that has been approved by EH&S, **Nanomaterial Standard Operating Procedure Template**
- For questions or assistance with the nanomaterial SOP contact EH&S, 205-934-2487.

16.5.4 Personal Protective Equipment

- May include:
  - Safety glasses
  - Gloves
    - Different nanoparticles will require different types of gloves.
    - See Personal Protective Equipment section for details on glove types.
  - Lab coats
  - Respiratory protection
    - Please enroll with **Employee Health** to be fitted for respiratory protection
  - Specialized PPE

16.6 Medical Screening

Any labs working with nanoparticles should enroll with UAB **Employee Health** and list working with nanoparticles.

CHAPTER 17: WORKING with PYROPHORIC and WATER REACTIVE CHEMICALS

Pyrophoric chemicals are liquids, solids or gases that have the potential to spontaneously ignite in air at temperatures of 54 °C (129 °F) or below. They may also exhibit other properties like *corrosive, water reactive and peroxide forming,* etc. Pyrophoric materials are *often* water-reactive and will ignite when they come in contact with water or even humid air. Improper handling of these materials can cause fires or explosions. These reactions can cause serious injury or even death and significant damage to the facility. This section is intended to advise all laboratories at UAB on proper use, storage and disposal of pyrophoric/water reactive chemicals to minimize risk to personnel, environment and facilities.

17.1 Common Pyrophoric & Water Reactive Chemicals

Tables 17.1 and **17.2** below provide lists of pyrophoric and water reactive chemicals. **Note: this list is not exhaustive. Please consult the chemical SDS to determine the hazards and warnings.*

Table 17.1. Pyrophoric Liquids (NOTE: *LIST IS NOT EXHAUSTIVE*)

Pyrophoric Liquids	Examples	Storage Conditions
Alkylaluminum Reagents	Trimethyl aluminum	Stored in HC solvents or neat (VERY pyrophoric)
Alkyllithium reagents	Tert-butyllithium	Stored in HC solvents
Alkenyl lithium	Alkenyl lithium	Stored in HC solvents
Aryl lithium reagents	Aryl lithium	Stored in HC solvents
Alkynyl lithium reagents	Lithium acetylide	Stored in HC solvents
Alkyl zinc reagents	Diethyl zinc	Stored in HC solvents
Boranes	Decaborane	Stored in HC solvents; neat (VERY pyrophoric)
Grignard reagents	R-Mg-X Ph-Mg-X	Stored in HC solvents
Alkylated (fully or partially) derivatives of metal and nonmetal hydrides	Diethyl aluminum hydride, diisobutyl aluminum hydride, dichloro(methyl)silane)	Usually in liquid form or in solution
Alkylated metals	Butyl lithium, triethyl boron, trimethyl aluminum	Usually in liquid form or in solution
Non-metal alkyls	R3B, R3P, R3As; Tetramethyl silane, tributyl phosphine	Usually in liquid form or in solution
Metal alkyls & aryls	RLi, Rna, R3Al, R2Zn	Stored in HC solvents or under nitrogen

*HC = Hydrocarbon **X = Halide

Table 17.2. Pyrophoric Solids (NOTE: *LIST IS NOT EXHAUSTIVE*)

Pyrophoric Solids	Examples	Storage Conditions
Alkali metals	Li, Na, K, NaK alloy	Stored in HC solvents or under nitrogen
Alkylated metal alkoxides or halides	Dimethylaluminum chloride, diethylethoxy aluminum	Stored in HC solvents or under nitrogen
Finely divided metals	Al, Bi, Ca, Co, Hf, Fe, Mg, Mn, Pd, Pt, Sn, Ti, U, Zn, Zr	Stored in HC solvents or under nitrogen
Low valent metals	$TiCl_2$	Stored in HC solvents or under nitrogen
Metal hydrides	KH, NaH, $LiAlH_4$, UH_3	Stored in HC solvents or under nitrogen
Nonmetals	White phosphorous	Stored in HC solvents or under nitrogen
Metal carbonyls	Dicobalt actacarbonyl ($Co_2(CO)_8$, nickle carbonyl($Ni(CO)_4$, Iron carbonyl ($Fe(CO)_5$)	Stored in HC solvents or under nitrogen
Used hydrogenation catalysts	Raney Ni (haz due to adsorbed H_2 gas)	Stored in HC solvents or under nitrogen
Copper fuel cell catalysts	$Cu/ZnO/Al_2O_3$	Stored in HC solvents or under nitrogen
Methantellurol	CH_3TeH	Stored in HC solvents or under nitrogen
Finely divided Iron sulfides	FeS, FeS2, Fe_3S_4	Stored in HC solvents or under nitrogen
Potassium sulfide	K_2S	Stored in HC solvents or under nitrogen
Aluminum phosphide	AlP	Stored in HC solvents or under nitrogen
Depleted Uranium	DU	Stored in metal cylinder**

*HC = Hydrocarbon ** CALL RAD SAFETY IF USING

17.2 Working Safely with Pyrophoric and Water Reactive Materials

The main hazard associated with pyrophoric and water-reactive chemicals is fire upon contact with air or moisture. The high level of reactivity associated with these chemicals requires them to be handled with extreme caution.

17.3 Hierarchy of Controls

17.3.1 Engineering Controls – Glove Boxes and Fume Hoods

Glove boxes with an inert atmosphere are strongly recommended for the safe use of pyrophoric materials especially for transfers. If glove boxes are not available, at a minimum the experiments must be performed in a fully functioning, certified fume hood.

Those who work with pyrophorics must have training on the use *and* location of the emergency equipment. Emergency equipment includes – and must be available within 10 seconds (or 50 feet) of travel time:

- Fire extinguishers
    - Class A, B, C (dry chemical) is appropriate for pyrophoric liquids and supporting flammable solvents.
    - Class D is to be used for reactive metals
    - A sand bucket should be available *within arm's length* for small fires
    - DO NOT use extinguishers *containing or developing:*
        - Water
        - CO_2
        - Halogens
        - Not suitable for fires caused by organolithium compounds and react violently
- Emergency safety showers
    - Not greater than 10 second/50 feet travel time
- Emergency eyewash station
    - Not greater than 10 second/50 feet travel time

Gas cabinets are required for the storage of pyrophoric gases. Outside of each cabinet, there should be a remote manual shutoff device available in case of an emergency. Pyrophoric gas flow, purge and exhaust systems should have redundant controls that prevent pyrophoric gas from igniting or exploding. Gas cabinets must be located in areas with continuous mechanical or natural ventilation.

17.3.2 Administrative Controls

- Reduce the quantities purchased and stored to a minimum.
    - If possible, substitute with a non-pyrophoric chemical
- Purchase pyrophoric materials dissolved in solvents if-at-all-possible.
- Conduct experiments in smallest scale possible
- Pre-Approval
    - All laboratory workers working with pyrophoric materials must have pre-approval from the PI/laboratory supervisor
- Pyrophoric and water reactive chemicals should be handled only by those experienced in safe handling.
    - The PI is responsible for ensuring all laboratory workers are trained ***before*** working with pyrophoric chemicals
        - **CS305:Working Safely with Pyrophoric Chemicals at UAB**
        - Lab specific training

- Training must be documented
- Consult EH&S for further assistance 205-934-2487

- PI is responsible for conducting/reviewing with laboratory workers *before* work begins
  - Hazard analysis
  - Emergency response protocols
  - Hazardous chemical SOP should include all of this information
    - (**Hazardous Chemical SOP Template**)
- Never work alone
  - Working alone not permitted.
  - At least *two* people must be present in the laboratory at all times.
- Use of pyrophoric chemicals and materials are ***forbidden*** outside of regular business working hours (8:00 am to 5:00 pm).

17.3.3 Personal Protective Equipment

ALWAYS wear appropriate personal protective equipment (PPE) while working with pyrophoric materials.

- Eye protection
  - ANSI approved safety goggles
  - Face shield
  - Safety glasses/spectacles are *not* appropriate for work with pyrophoric materials
- Hand protection
  - Nitrile gloves
    - Only as base layer under neoprene gloves
    - Can ignite if pyrophoric materials spills on gloves
  - Heavy duty chemical-resistant gloves
    - Neoprene gloves (*see PPE section*)
- Lab Coats/Clothing
  - Flame-resistant lab coat
    - If experiments involve transfer of pyrophoric material
    - All clothing under lab coat should be 100% cotton – including socks

17.4 Handling of Pyrophoric Chemicals

- No open containers of pyrophoric liquids are permitted inside fume hoods
  - Dispensing in fume hood must be done from a sure-seal type bottle using a syringe or cannula.
  - Open dispensing is only permitted inside a glove box or inert environment
    - Fume hood sash should be lowered to the lowest working position
    - Highly recommend working behind a blast shield within the hood
- Fume hood should not contain any flammable chemicals while work with pyrophorics is being performed.
- Solids not stabilized under mineral spirits (or other solvents) should be handled *only* inside of an inert atmosphere glove box.

- Water reactive solids not stabilized under mineral spirits (or other solvents) should be handled *only* inside of an inert atmosphere glove box.
- Needles, spatulas, wipes or any other items in contact with pyrophorics/water reactives must be kept in an inert atmosphere or neutralized per manufacturer's instructions before exposing to water or air.

17.5 Waste Disposal/Manifesting Pyrophoric Chemicals

Any pyrophoric materials that are unwanted and need to be disposed of should be kept in appropriate storage conditions as they were in the laboratory. For example, if excess sodium metal needs to be discarded, it must remain submerged in hexanes as it was when being stored in the laboratory. It should also be noted on the manifest the storage solution or gas used. When manifesting through EHSA, make sure to indicate in the "Additional Waste Content" section the words **"Danger – Pyrophoric Chemical"**, this will appear on the manifest to alert support facility personnel of the hazard. If there are any questions about manifesting reactive or pyrophoric chemicals, please contact the chemical hygiene officer at 205-934-4798 or the support facility at 205-934-3797 or 205-917-4766.

17.6 Training

Every laboratory member that purchases, stores and uses pyrophoric materials must have appropriate training. Training should include both EH&S provided online training; **CS305: Working Safely with Pyrophoric Chemicals at UAB** and lab-specific hands-on training. The PI or laboratory supervisor is responsible for developing the hands-on training and documenting the specific training for each laboratory member. EH&S is available to assist in developing training if needed, 205-934-2487 or ChemicalSafety@uab.edu.

17.7 Storage

17.7.1 Pyrophoric Liquids/Solids

- Use and store minimal amounts of chemicals in the laboratory.
- Do not store with flammable materials or in a flammable storage cabinet.
    - Original container must be in sealed secondary containment if flammable cabinet is the only safe option.
- Never store with corrosive materials that could damage the container(s).
- Keep material in airtight containers away from
    - Combustible materials
        - Paper
        - Flammables
    - Water
    - Oxidizers
    - Heat sources

    - Vibration sources
    - Air
- Do not transfer to secondary containers unless following the guidelines from above.
- Keep material in original containers with clear and legible labeling including appropriate hazard warnings.
- Ensure the integrity of the container is maintained as packaged and shipped.
- Check regularly to make sure there is adequate protective solvents in the container
    - Oil
    - Kerosene
    - Inert gas
- NEVER try to return unused amount back into the original container
- Always store per SDS recommendations
- Organolithium compounds must be stored inside an approved flammable storage refrigerator with metal can as secondary containment.
- Always put cap back on (for Sure-Seal) to protect septa.

17.8 Pyrophoric Gases

- Keep size of container and quantity of gas cylinders to a minimum.
- Materials must be stored in approved gas cabinets.
- Remote manual shutdown must be provided to pyrophoric gas flow outside each gas cabinet.
- Pyrophoric gas flow, purge and exhaust systems should have controls that prevent pyrophoric gas from igniting or exploding, including:
    - Excess flow valves
    - Flow orifices
    - Mass flow controller sizing
    - Process bypass line control
    - Automatic gas shutdown
- Emergency back-up power should be provided for all:
    - Electrical controls
    - Alarms
    - Safeguards associated with the storage and process systems.
- All process systems components and equipment should be purged with inert gas

17.9 Transferring Pyrophoric Liquids

- Never use a syringe that has a volume less than double the volume being withdrawn. Ensure ALL required PPE is present before beginning any material transfer
    - Eye protection
    - Hand protection
    - Fire-resistant lab coat
- Confirm access to emergency equipment.
    - Fewer than ten (10) second travel time to emergency shower and eyewash station

  - An appropriate fire extinguisher within ten (10) seconds
  - Small bucket of sand in arm's length for small fires.
- Ensure all engineering control are working properly
  - Preferred inert atmosphere glove box
  - Certified chemical fume hood (if glove box is not accessible).
- Teflon-tipped glass syringes (gas tight) are best for pyrophoric transfers
  - Disposable plastic syringes have good seal on plunger and will suffice if glass is not available
  - Needles must be long enough to withdraw the material without tilting bottle.
  - Never use syringes for more than twenty milliliters (20 mL) at one time.
  - Never reuse syringes for a second withdrawal.
    - Plunger could stick in barrel and residual material in barrel could form a solid when exposed to air and cause the plunger to stick.
  - For volumes greater than 20 mL, cannulas (double ended needles) are the best choice.
- Limit the amount of material used in one experiment to fifty milliliters (50 mL).
  - Transfers must be conducted using the cannula system.
  - Experiments requiring more than 50 mL of pyrophoric liquids requires written approval from the PI.

17.10 Cleaning of Needles and Syringes When Using Pyrophoric Reagents

A small amount of residual pyrophoric material will inevitably remain in the syringe. There are steps to quench and wash the syringe.

- Quench syringe with a non-reactive solvent three (3) times
  - Solvents such as hexane
  - Discard as hazardous waste
- Rinse again with alcohol three (3) times.
  - Discard as hazardous waste
- Syringe and needle can now be cleaned with water.

17.11 Emergency Preparation

Extreme caution is required due to potential spontaneous ignition when working with pyrophoric and water reactive chemicals.

In the event of a spill, it is ***NOT RECOMMENDED*** to clean the spill (regardless of amount) with a normal spill kit:

- Turn off any ignition sources (if safe to do so)
- Activate fire alarm and evacuate the building ***immediately***.
- Call
  - 911 from campus phone (205-934-3535 from cell phone)

        - Inform 1st responders of pyrophoric chemical
    - **EH&S Emergency On-Call number at 205-917-4766**
    - **EH&S when safe to do so at 205-934-2487 or** ChemicalSafety@uab.edu
- If anyone is exposed or on fire, immediately place under emergency shower and rinse with copious water flow immediately
    - Alert emergency personnel when calling that a person has been exposed and provide the chemical name and any other pertinent information requested.

NEVER ATTEMPT TO CLEAN UP A PYROPHORIC CHEMICAL SPILL.

Immediately **call 911 from a campus phone (205-934-3535 from a cell phone) and then 205-917-4766.**

For additional information or assistance please contact EH&S, 205-934-2487 or ChemicalSafety@uab.edu.

CHAPTER 18: HAZARDOUS CHEMICAL USE in ANIMALS

There are certain criteria used in deeming a chemical or drug as hazardous. The American Society of Hospital Pharmacists publish criteria that is used as the basis for guidelines in dealing with hazardous chemicals and cytotoxic chemicals. The list includes:

- Genotoxicity (mutagenicity)
    - Chemical agents that damage genetic information within a cell causing mutation which could lead to cancer.
    - Examples include:
        - Agents that can cause DNA damage
        - UV radiation
        - Pyrrolizidine
        - Alkaloids
- Carcinogenicity
    - Chemical agent that promotes development of cancer
    - Examples include:
        - UV radiation
        - Radon
        - Asbestos
        - Formaldehyde
        - Cigarette smoke
        - Etc.
- Teratogenicity
    - Chemical agent that interferes with the normal fetal development and causes congenital disabilities
    - Examples include:
        - Alcohol
        - Elicit drugs such as cocaine, methamphetamines, opioids, etc.
        - Some medications such as antimicrobials, anticoagulants, hormones, etc.
        - Radiation exposure
        - Mercury
        - Lead
        - Heavy metals
- Serious organ damage
    - Lungs
    - Skin
    - Liver
    - Kidneys
    - Nervous system
    - Heart
- Other toxic manifestation at low doses in experimental animals
- Investigational drugs

Persons administering these chemicals in animals or using them in research should refer to the **UAB Institutional Research Core Program** - **Animal Care Policy**

The guidelines below are also beneficial to any laboratories using hazardous chemicals.

18.1 Exposure to Hazardous Substances

Peer-reviewed studies have shown that workplace exposures to hazardous drugs and chemicals can cause both acute and chronic health effects such as skin rashes, adverse reproductive outcomes including:

- Infertility
- Spontaneous abortions
- Congenital malformation
- *Possibly* leukemia and other forms of cancer

The health risk associated depends on two things:

- How much of the material they are exposed to
- How toxic the material is

Potential exposures can occur through:

- Inhalation
- Mucous membrane contact
- Percutaneous injury or absorption
- Ingestion

The main issue of concern in the laboratory are *accidental* exposure caused by contact with:

- Mucous membranes
- Transdermal absorption (depending on diluents used)
- Inhalation of toxins inadvertently aerosolized

Laboratory personnel can be protected from exposures to hazardous drugs through:

- Engineering controls
- Administrative controls
- Personal protective equipment

All work with these chemicals and drugs must be registered with EH&S and approved by the Chemical Safety and Environmental Management Committee (CSEMC). The project must also have an EH&S approved chemical-specific standard operating procedure (SOP) ***prior to*** the start of the laboratory work. The PI must ensure training on the chemical-specific hazards and SOP. Training must be documented for all laboratory personnel ***prior to*** the start of the work. The training must include, but is not limited to:

- Appropriate workplace practices
- Personal protective equipment
- Health and physical hazards of the chemical/material

- Signs and symptoms associated with exposure
- Emergency response procedures

Some of the chemicals in this category may fall into the list of chemicals included in the 1993 Chemical Weapon Convention. Examples include:

- Chlorine
- Sulfur
- Nitrogen mustard gases
- Etc.

There may be additional restrictions imposed by the FBI on the amounts a laboratory can possess at any given time.

The guidelines below pertain to all research including animal use involving these highly toxic chemicals at UAB.

18.2 Planning and Preparation for Use

1. Prior to any work with these toxic chemicals, you are required to register your project with EH&S and to get the approval of the appropriate committees (CSEMC/IBC).
2. Develop a written laboratory-specific SOP, specific to the chemical being used.
    a. A template can be found here **Hazardous Chemical SOP Template**
3. PIs must provide and document toxin-specific SOP training to personnel directly working with toxins and any personnel authorized or required to be in the laboratory when this work is being conducted.
    a. Everyone involved with the work must read and sign the SOP document.
4. Ensure the SDS is always available to all lab personnel.
5. Designate a storage area in a secure location and maintain an accurate inventory.
    a. At times this may require a locked container such as:
        i. Freezer
        ii. Refrigerator
        iii. Cabinet
6. Designate a laboratory workspace and certified biological safety cabinet (BSC), fume hood, glove box or other approved containment device for the work.
    a. The laboratory facility requirement may vary based on the level of hazard posed by the specific toxin and the procedures being performed.
7. If possible, ***do not*** work with these materials in solid or powder form.
    a. If it is necessary to purchase in powder or solid form, purchase pre-diluted or pre-weighed vials with the minimum quantity necessary to perform work.
    b. Additional precautions may be needed if working with powder or solid.
        i. Such as N95 mask or respirator.
8. Two or more trained individuals should be present in the laboratory during high-risk procedures.
    a. E.g., making up solutions from powdered stocks.
9. Determine the appropriate chemical and/or physical inactivation method(s) for the specific chemical.
10. Ensure equipment/reagents needed for inactivation are available.

11. Ensure a material specific spill cleanup kit is readily available.

18.3 Engineering Controls

1. Designate a certified fume hood, glove box or other approved containment space.
    a. Consider the properties of the specific chemical and procedures when selecting a containment device.
2. If centrifuging materials containing these chemicals, centrifuge safety cups or sealed rotors must be used.
    a. Outside surfaces routinely decontaminated.
    b. Open the sealed cups or rotors inside containment.

18.4 Administrative Controls (Work practices) for Reconstitution, Dilution and Administration

1. Post sign on room door "**Toxic Materials in Use – Authorized Personnel Only**"
2. Limit the work to designated rooms and work areas that operate under negative pressure to adjoining spaces, rooms and public corridors.
3. Work only in a fume hood, glove box or other approved containment.
4. Transport ***only*** in labeled, leak/spill-proof, non-breakable secondary containers.
5. Perform preparations over plastic backed absorbent pads.
6. After completion of tasks, dispose of pads in waste streams appropriate for the material.
7. Utilize safe sharps procedures.
    a. Have sharps containers in the immediate work area.
    b. Have needle locking syringes or disposable syringe needle units are recommended.
    c. Should be properly disposed of promptly after use.
8. If administering to animals, follow all ARP guidelines.
9. Decontaminate containers before they are removed from the fume hood or glove box.
10. Decontaminate the exterior of the closed primary container and place it in a clean secondary container.
11. Decontaminate the fume hood or approved containment and all surfaces used upon completion of tasks with appropriate inactivating agent and contact time.
12. All potentially contaminated disposable items must be placed in a hazardous waste bag and disposed of as hazardous or biohazardous waste, depending on the toxin used.
13. Wash hands immediately upon completion of tasks and always before leaving the laboratory.

18.5 Personal Protective Equipment

1. Wear safety glasses with side shields or chemical splash goggles.
2. Wear a laboratory coat with long sleeves, smock, apron or coveralls.
    a. Consider using disposable PPE.
3. Wear gloves that are impervious to the chemical as week as the diluent.
4. Wear face protection, such as a face shield, when splash/splatter is possible.

5. Respiratory protection may be required if an airborne hazard is present when work is done outside of approved containment.
    a. Contact **UAB Employee Health** for information on enrolling in UAB's respirator program.

CHAPTER 19: SUSTAINABILITY in LABORATORIES

Laboratory research often involve energy intensive procedures and as a result, lab buildings typically have energy demands four to five times greater than office buildings. Laboratories require many more air changes than an office building. Laboratories also use fume hoods and other specialty equipment to ensure the health and safety of the occupants. Efforts to reduce environmental and financial costs depends on these three principles:

1. Conservation
2. Waste reduction and resource management
3. Recycling

19.1 Conservation

There are a few ways to reduce energy consumption in laboratories. Some tips and tricks to reduce the energy consumption in laboratories are provided by:

- UAB **Sustainability**
- UAB **Green Labs**
- UAB **Lab Recycling**

19.2 Cold Rooms, Refrigerators and Freezers

Energy consumption can be minimized while using cold storage units by:

- Purchase energy efficient technologies when buying new units
- Turn off/unplug unused units
    - Unused equipment can be donated to **UAB Surplus**
        - Any equipment donated must be properly decontaminated and if applicable, a release label from EH&S.
        - **Equipment Decontamination for Surplus**
- Set temperatures at necessary levels instead of lowest set point possible.
- Conduct regular inventory
    - Dispose of unwanted material.
    - Clean out samples and materials that are expired or no longer needed.
- Perform periodic defrosting
- Change filters regularly
- Clean exposed coils regularly
- Clean door seals to prevent mildew/mold that can prevent doors from sealing properly
- Place freezers in areas not in direct sunlight if possible
- Do not leave doors open for extended periods

19.3 Liquid Nitrogen (LN2) Use

Liquid nitrogen manufacturing is a high energy consumption process. Freezers that use liquid nitrogen require a large amount of LN2 to maintain ultra-low temperatures. Reduction of LN2 use can conserve energy. There are some methods to conserve LN2:

- Replace with more energy efficient ultra-low temp (ULT) freezers whenever possible.
- Minimize the duration that the freezer door is open.
- Use freezer only for essential samples.
- Store frequently accessed samples in an area of the freezer that is easily accessible to avoid keeping the door open for extended periods.
- Keep an inventory list on the door of the freezer to avoid keeping the door open for extended periods.
- Reduce the number of LN2 freezers in the lab by sharing with collaborators/neighbors when possible.
- Conduct regular inventory to dispose of unwanted or expired samples.
- Ensure door is closed properly.

19.4 Fume Hoods

Fume hoods are ventilated, enclosed workspaces intended to capture, contain and exhaust

- Harmful fumes
- Vapors
- Particulate matter

Fume hoods are large consumers of energy. Fume hoods run constantly to maintain pressure and flow rates in the laboratory and can consume as much or more energy than a residential home. Laboratories generally use 100% outside air rather than recirculating, this increases heating/cooling cost. The fans used to move the air use a significant amount of energy. The best way to reduce fume hood energy consumption is to keep the hood sash down when not in use.

In a variable flow fume hood, keeping the sash down reduces the fan speeds to a minimum, as less air displacement is needed. The sash is an important safety component in protecting the laboratory worker. Sashes should be opened only to set up or modify an experiment. The sash should be kept below the marked height while working in the hood. Hood sashes should remain down at all other times. Keeping the sash closed when not actively in use is the easiest way to save energy in the laboratory.

There are a few other practices that can reduce the energy consumption of fume hoods:

- Never use a fume hood for chemical storage
- Never use the fume hood to evaporate residual solvents from bottles
- Keep fume hood clean by removing all unnecessary items when not in use
- Lock and de-commission unwanted fume hoods
- Never block baffle in fume hood with equipment or any other materials

UAB **Sustainability** can provide more tips on improving energy conservation in the laboratory.

19.5 Oven Use

- Turn off when not in use
- Reduce number of times door is opened while on/in use
- Determine time needed for oven to come to desired temperature and post on oven door to reduce amount of time oven is on without being used.

The UAB **Green Labs** can provide detailed information on making laboratories more energy efficient. Below are just a few tips:

- Post signage reminding all laboratory personnel to turn off lights when no one is in laboratory.
- Use energy efficient lighting in laboratory.
- Turn off electrical equipment when not in use
- Use timers to automatically turn equipment on/off as needed.
- Unplug equipment when not in use.
- Set computer monitors to sleep after ten (10) minutes of inactivity.
- Close window blinds to keep room cooler.

19.6 Water Conservation

When upgrading water-using equipment such as autoclaves, dishwashers, synthesis and distillation processes, choose models and apparatuses specifically designed for water and energy conservation. UAB **Sustainability** is available for assistance as needed.

- Install water misers for autoclaves
    - Shown to reduce water use by up to ninety (90) percent.
- Use flow reducing valves, timers and/or automatic shut-off mechanisms
- Run dishwashers only when full
- Reduce rinse cycles on dishwashers if possible
- Do not run the tap when washing glassware
- Use a recirculation pump for distillation processes
    - Can also prevent flooding should the tubing pop off of the condenser
- Use waterless condensers for distillation processes
    - Many options from laboratory vendors
- Use timers on critical or continuous water uses
- Report dripping or leaking faucets
- Eliminate water aspirators
    - Use vacuum pumps or in-house vacuum lines (with in-line filter installed)

19.7 Waste Reduction and Resource Management

Waste reduction can be achieved by:

- Reducing the amount of material purchased
  - Purchase fewer chemicals
  - Utilize **EHSA inventory tool** to keep an accurate chemical inventory
  - Purchase **Green Chemicals**
  - Use EPA **Green Chemistry** education materials
  - Substitute hazardous chemicals with less hazardous alternatives
  - Simplify procedures
  - Reduce experimental scale where appropriate
- Finding alternatives to disposal
  - Redistribution to other laboratories
    - Encourage PIs to redistribute unused chemicals among neighboring or collaborating laboratories.
      - EH&S can assist in transferring inventory in EHSA to other registered PIs
  - Follow **ACS Green Chemistry Principles**
  - Reduce excess equipment/supplies
    - Encourage departments to share equipment among colleagues and collaborators.

19.8 Reduce Use of Paper

- Set printers to print double-sided
- Password common use printers/copiers to reduce unnecessary printing
- Recycle paper
- Go paperless wherever possible

19.9 Managing Hazardous Waste

Proper disposal of hazardous materials is fundamental to minimizing the environmental impact of the laboratory. It is also mandated by law. Environmental Health and Safety is available to assist in proper disposal of chemical, biological and radioactive waste. The **EHSA** tool can help in understanding and properly manifesting hazardous and non-hazardous waste.

19.10 Recycling

Below is a list of some items that can be collected for recycling:

- Batteries
- Plastics
  - Pipette tip boxes
  - Plastics not contaminated with hazardous waste
  - Containers with a 1, 2 or 5 on the bottom
- Paper
  - Copy paper

    - Cardboard boxes
- Printer ink/cartridges

For more information on UAB's recycling program, visit **UAB Recycling.**

For any additional questions or information on energy conservation and sustainability in laboratories, contact UAB's **Sustainability** program.

UAB CHEMICAL & LAB SAFETY PROGRAM

Environmental Health & Safety

933, 19th St. S. (CH19 # 445)

Email: ChemicalSafety@uab.edu

Phone: (205) 934-2487

Drafted: May 2024