UNIVERSITY of HOUSTON
ENVIRONMENTAL HEALTH AND SAFETY

Chemical Hygiene Plan

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1.0 Introduction

The purpose of this Chemical Hygiene Plan is to define work practices and procedures in order to protect students, laboratory workers, researchers, and supervisors at the University of Houston from the health and physical hazards associated with the use of hazardous chemicals. The Chemical Hygiene Plan is consistent with the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) standard entitled "Occupational Exposures to Hazardous Chemicals in Laboratories" (Code of Federal Regulations, 29 CFR 1910.1450) and the Texas Hazard Communication Act (Chapter 502 of the Texas Health and Safety Code).

OSHA has defined a hazardous chemical as "a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees." In addition, OSHA defines a laboratory as "a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis." Finally, laboratory workers are defined in the OSHA Lab Standard under the definition of "employee" as "an individual employed in a laboratory workplace that may be exposed to hazardous chemicals in the course of his or her assignments."

UH Environmental Health and Safety (EHS) defines laboratory personnel as Principal Investigators, Laboratory Managers/Supervisors, Research Scientists, Postdoctoral Fellowships, Temporary Visiting Researchers, Graduate Students, Undergraduate Students, High School Students and Volunteers working in the laboratory. If there is any confusion about whether a particular workplace is considered a laboratory that utilizes hazardous chemicals, or whether someone is considered laboratory personnel, EHS will, upon request, make this determination.

All laboratory personnel must be familiar with this Chemical Hygiene Plan and together share the responsibility for creating a safe and healthy work environment. In addition to the Chemical Hygiene Plan, laboratory personnel shall be cognizant of and adhere to the procedures outlined in the Biological Safety Manual, Radiation Safety Manual and Regulated Waste Manual. These documents are available on the EHS website at https://uh.edu/ehs/commons/manuals/ . Further information is available by contacting EHS at 713-743-5858 or ehs@uh.edu.

2.0 Responsibilities

Environmental Health and Safety's main purpose is to support the University of Houston in its mission of higher education and research. The Department's efforts are directed at assisting the University in identifying safety hazards and controlling such hazards through protective equipment, hazard mitigation methods, and the development and presentation of safety training programs.

2.1 Chemical Hygiene Responsibilities

2.1.1 Deans, Directors, and Heads of Academic and Administrative Units

Deans, Directors, and Heads of Academic and Administrative Units have the primary responsibility for the health and safety of their staff and students. Specific responsibilities regarding the implementation of the Chemical Hygiene Plan include:

- Ensure compliance with all requirements for chemical safety and hygiene within their departments and colleges;
- collaborate with faculty and staff to adapt this Chemical Hygiene Plan to include lab-specific guidelines and to develop strategies to implement the Plan;
- make budget arrangements for health and safety improvements.

2.1.2 Principal Investigators and Designees in Charge of Supervising Laboratories

Principal Investigators and Designees in charge of supervising laboratories have the following responsibilities for implementing the Chemical Hygiene Plan:

- Perform hazard assessments, develop/approve laboratory-specific standard operating procedures (SOPs) for all hazardous chemicals and procedures;
- inform and train laboratory personnel concerning chemical safety as required by this Plan and retain training records and all documentation;
- implement and enforce rules and standards concerning health and safety for laboratories;
- ensure compliance of laboratory personnel with this Plan;
- ensure the availability and enforce the use of: appropriate personal protective equipment, safety equipment, emergency equipment, Safety Data Sheets (SDSs), and relevant reference materials;
- remain cognizant of chemicals stored and used in laboratories and their associated hazards;
- dispose of chemicals no longer needed by submitting an on-line waste pick up request to Environmental Health and Safety;
- conduct internal inspections of laboratories for health and safety concerns; and,
- request assistance from Environmental Health and Safety as needed.

It is the responsibility of the Principal Investigator or Designee to ensure that Particularly Hazardous Substance (PHS) determination is conducted on all existing chemical inventories and on all future chemical purchases. Furthermore, prior to beginning work with a PHS, or once the PHS determination is made, Principal Investigators or Designees shall complete a lab-specific PHS Standard Operating Procedure (PHS SOP). Principal Investigators must ensure that laboratory personnel are trained, understand, and implement the procedures as directed in the SOP. For more information please see Chapter 5.

2.1.3 Laboratory Personnel

Laboratory personnel's responsibilities regarding implementation of the Chemical Hygiene Plan are as follows:

- Complete General Laboratory Safety Orientation and other lab-specific trainings provided by EHS and the Principal Investigator before undertaking any activity in the laboratory;
- plan and conduct laboratory operations in accordance with this Chemical Hygiene Plan and lab-specific documentations;
- report all hazardous conditions to the Principal Investigator or Designee;
- wear or use appropriate Personal Protective Equipment (PPE);
- report any job-related injuries or illnesses to the Principal Investigator or Designee and seek treatment immediately;
- refrain from the operation of any equipment or instrumentation without proper instruction and authorization;
- remain aware of the hazards of the chemicals in the laboratory and how to handle, store and segregate hazardous chemicals safely;
- request information and training if unsure how to handle a hazardous chemical or perform a dangerous procedure.

All laboratory personnel approved to work with a particularly hazardous substance (PHS) shall be trained by the Principal Investigator or Designee and strictly comply with all instructions and procedures. For more information please see Chapter 5.

2.1.4 Environmental Health and Safety Department (EHS)

Specific to this Chemical Hygiene Plan, the responsibilities of the Environmental Health and Safety Department include the following:

- Provide technical assistance to laboratory personnel concerning appropriate storage, handling and disposal of hazardous chemicals;
- provide general and specialized laboratory safety trainings;
- conduct exposure assessments and laboratory surveillance as needed or upon request;

- make routine, as well as special, health and safety inspections;
- provide technical assistance concerning personal protective equipment and laboratory safety equipment;
- remain current on industrial best practices, standards, rules and regulations concerning chemicals used at University of Houston.

2.2 General Responsibilities

Preventing workplace injuries, exposures, and illnesses is the responsibility of every member of the campus community. Specific responsibilities are assigned to more senior members of the research and teaching community in order to implement, and ensure compliance with this Plan by their subordinate personnel.

2.2.1 The Chancellor

The Chancellor has overall responsibility for compliance with health and safety requirements at all facilities and programs under campus control.

2.2.2 Vice Chancellor for Research

The Vice Chancellor for Research is responsible for the implementation of this Plan in all applicable research and teaching laboratories within his or her jurisdiction.

2.2.3 Deans, Department Chairpersons

Deans and Department Chairpersons are responsible for communicating, promoting and enforcing this Plan in their respective research and teaching areas.

2.2.4 College/Department/Center Chemical Safety Officer

College/Department/Center Chemical Safety Officer serve as a health and safety resource for co-workers and the liaison between the college/department/center and EHS. (Appendix 1)

2.2.5 Principal Investigators and Laboratory Management Staff

Principal Investigators and laboratory management staff are responsible for complying with this Plan and ensuring their laboratory personnel receive appropriate training and comply with this Plan as it relates to their research and teaching activities.

2.2.6 All Laboratory Personnel

All laboratory personnel are responsible for following all safety requirements including how to work safely with substances designated as particularly hazardous substances.

2.2.7 The UH Department of Environmental Health and Safety (EHS)

EHS is responsible for inspection of laboratories and for monitoring campus compliance with this Plan. In cases where laboratory activities pose an immediate danger to life or health, designated EHS staff have the responsibility and authority to order the temporary cessation of the activity until the hazardous condition is abated.

2.2.8 The UH Chemical Hygiene Officer

The UH Chemical Hygiene Officer, also referred to as the UH Chemical Safety Officer, is responsible for facilitating necessary reviews of procedures that involve the use of hazardous materials. The reviews of procedures shall accommodate the requirements of this plan as well as other current and applicable guidelines and regulations.

3.0 Control Measures

3.1 Engineering Controls

The primary objective in controlling occupational exposures is to prevent contamination of the work atmosphere. This shall be achieved first by use of a chemical fume hood, or other enclosure. The second way in which this is achieved is by making sure the ventilation is such that the air pressure in the laboratory is negative with respect to the hallway, thus assuring airflow into the laboratory.

3.1.1 Fume hood

The best way to prevent exposure to airborne hazards is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices. Operations such as running reactions, heating or evaporating solvents, and transfer of chemicals from one container to another must be performed in a hood when there is reasonable potential for hazardous material exposure.

Fume hoods will conform to the following specifications.

- Where applicable, the hood shall have a working sash.
- When the hood sash is open approximately eighteen (18) inches, an average face velocity of 80-120 feet per minute (FPM) at the hood face shall be provided.
- The hood enclosure must be fire- and chemical-resistant.
- In new construction, consideration shall be given to locating the hood such that ambient air currents do not unacceptably reduce the containment efficiency of the hood.
- In new construction the hood shall be designed to produce laminar airflow.
- The hood shall have only modifications approved by EHS. Any modification must not detract from the hood performance.
- In new construction, the room in which the hood is located shall have a source of sufficient make-up air to replace the air that is exhausted out.
- The fume hood must be appropriate for the material used within (e.g., perchloric acid usage).
- Airflow shall be such that contaminants within do not escape the fume hood, such as shown by a smoke test.

Face velocity and airflow monitors will be evaluated by EHS upon installation of chemical fume hoods. Each chemical fume hood at University of Houston is recertified annually for usage and performance. Where performance parameters fall outside specifications, work orders are initiated by labs to repair the hoods. When appropriate, a notice is placed on the fume hood indicating that it is not to be used until its performance is within the specified performance parameters.

Non-venting hoods (e.g., laminar flow hoods with in-room venting) shall be clearly labeled as such. No work with volatile hazardous chemicals shall be performed in hoods that do not vent

outdoors.

Laboratory personnel must confirm adequate hood performance before use and utilize the chemical fume hoods properly.

- Check if the hood has a yellow Hood Working Height and Air Flow Label on it and that the date on the label is not past the due date. If it is due, contact EHS immediately for recertification.
- New fume hoods must be equipped with air flow monitoring devices which will alert the user if there is a problem with air flow. For older hoods without air flow monitoring devices, a simple visible test to ensure flow into hoods and other ventilating devices is to tape a Kimwipe to the hood below the sash and note its movement when the exhaust fan is on.
- Typically, it is best to maintain the hood sash at a working height of 18 inches.
- Work at least 6 inches inside hood.
- Always close the fume hood sash when finished with the hood or when leaving experiments unattended.
- Laboratory personnel must be vigilant that their fellow lab personnel maintain closed sashes when they are not working at their hoods.
- Only ongoing experiments may be in the chemical fume hood and must not block air flow. Chemical fume hoods must never be used as chemical storage locations.
- Proper use of combination sash fume hood.
  - Combination sash hoods increase the flexibility of the fume hood, and reduce time and money spent on reconfiguring laboratory set-ups in order to move to the next task. When opening one vertical side of the sash to set up, laboratory personnel should shield themselves by standing behind the other closed vertical sash.
  - Combination sash hoods rely on completely closing the vertical sash while working through the horizontal sliders. Regular use of the horizontal sliding panels with the vertical sliding sash closed reduces chemical exposure and reduces energy expense.
  - The vertical sliding sash must only be open during set up, not while manipulating objects in the hood with reactions present. Always close the sash when finished with the hood or when leaving experiments unattended.

Protective equipment other than chemical fume hoods must be checked periodically by the Principal Investigator or Designee to ensure that the equipment is functioning properly. Any questions or requests for assistance in evaluation of hoods and other protective equipment shall be directed to Environmental Health and Safety (EHS) at 713-743-5858 or ehs@uh.edu.

Malfunctioning fume hoods must have the sash closed down completely and be marked “Do Not Use” if they are to be repaired. For more information, please see 3.4.2 Housekeeping, Maintenance, and Inspections section. To re-start an “Out of Service” fume hood, contact EHS. Malfunctioning eyewashes and safety showers must also be marked “Do Not Use".

3.1.2 Other Local Ventilation Devices

Exhaust air from glove boxes and isolation rooms must release into the hood exhaust system or its own ducted system. For more information, please refer to General Laboratory Safety Manual.

3.1.3 Special Ventilation Areas

Procedures involving radioactive aerosols, powders or gaseous products, or procedures that could produce volatile radioactive effluents shall be conducted in an approved hood, glove box or other suitable closed system. Such fume hoods shall be designed with smooth, non-porous materials and possess adequate lighting to facilitate work within. The hoods shall have a minimum face velocity of 100 FPM. Contact the Radiation Safety Office for further information on hoods for radioactive materials.

3.2 Personal Protective Equipment/Hygiene

Each laboratory must have access to protective apparel and equipment appropriate for the hazards present. Appropriate protective apparel and equipment shall be determined by the Principal Investigators or Designee in consultation with EHS. The Principal Investigators or Designees must assure that all laboratory personnel, including visitors, wear appropriate PPE where chemicals or hazardous materials are stored or used. Personal hygiene is another very basic aspect of laboratory safety. Wearing appropriate personal protection and practicing good personal hygiene, as described below, will greatly minimize exposures to hazardous chemicals during routine use and in the event of an accident.

- **Attire.** Legs and feet must be covered by closed-toe shoes, long pants or skirts which fully cover the legs (no sandals, open-toed shoes, or shorts), long hair must be confined and loose clothing and jewelry must be secured before beginning work. Wear a properly fastened lab coat specific for the hazards of the procedures performed in the laboratory. This includes, but is not limited to, using flame resistant clothing for use with pyrophorics, acid resistant protection when working with acids (especially HF or other strong acids), and protective items when working with hot or cold materials. The Principal Investigator or Designee is responsible for enforcing the protective clothing policy. More information will be available in "Appendix 2. UH Laboratory Dress Code Policy". Any laboratory personnel who is not wearing proper attire or PPE will be asked to leave the laboratory immediately by EHS until the situation is corrected.

- **Gloves.** Gloves are essential when working with hazardous substances. The proper gloves will prevent skin absorption, infection or burns. All glove materials are not equally effective in protection from chemical hazards. In many cases, latex examination gloves do not provide adequate protection from hazardous chemicals. Consult the Safety Data Sheet (SDS) of the chemical or the glove manufacturer, Chemical Resistance Selection Chart for Protective Gloves or contact EHS for assistance in appropriate selection.

- **Eye protection.** Safety glasses or chemical goggles must be donned before entering any

wet bench laboratory and any laboratory where soldering or machining/grinding occur. This applies to all laboratory personnel, visitors, and facility maintenance staff and contractors. Goggles are recommended when chemical splashes are possible. Safety glasses or goggles must be worn over prescription glasses and must be of a type intended to be worn over prescription glasses. The wearing of contact lenses in laboratories is an unsettled issue. If contact lenses are to be worn, the eyes must be protected by goggles when in the laboratory. The Principal Investigator or Designee will determine the level of eye protection required. All eye protection used must meet ANSI Z87.1 requirement.

Safety glasses shall be chosen to conform to the wearers face and minimize gaps around the glasses. Prescription safety glasses are acceptable as long as they have side shields for splash protection and conform to the wearer's face. EHS shall be consulted to assist in selecting proper eye protection.

- **Face shields.** Face shields worn over safety glasses may be required for certain processes as determined by the Principal Investigator (PI). Full-face shields must be worn when conducting a procedure that may result in a violent reaction. Full-face shields withbottom caps to protect under the chin are preferred due to the tendency to raise the chin when a splash occurs.

- **Hearing Protection.** Hearing protection will be provided for anyone working in an area where the sound levels exceed 85 dBa. Contact EHS to measure noise levels, to recommend proper hearing protection, and to evaluate the need for noise reduction engineering controls.

- **Personal hygiene.** Hands shall be washed frequently throughout the day, before leaving the laboratory, after contact with any hazardous material, before eating, etc.

3.3 Administrative Controls

3.3.1 General Standard Operating Procedures in a Chemical Lab

This plan provides a minimum set of guidelines for the handling of hazardous chemicals on campus. Individual administrative units, laboratories or research groups are required to develop more detailed procedures as their situations warrant. Laboratory-specific standard operating procedures are required for Particularly Hazardous Substances, or PHSs (more see 5.0 Particularly Hazardous Substances (PHS). Other chemical classes (such as explosives, peroxide formers, or pyrophoric materials) will also need lab-specific SOPs. In all situations, Principal Investigators or Designees will be responsible for enforcing adequate safety and hygiene measures in laboratories they supervise. If necessary, additional assistance from EHS is available.

Some rules or standard operating procedures, which apply to all laboratory personnel at UH include the following:

- **Complete trainings**: complete required EHS Safety Trainings and lab-specific chemical safety trainings by PI or the designee prior to beginning work. Training requirements can vary depending on the type of research being conducted. General Laboratory Safety training and other trainings provided by EHS will be documented by Environmental Health and Safety. Principal Investigator or Designee is to keep documentation of all lab-specific chemical safety trainings and submit to EHS upon request.
- **Be familiar with University Safety Plan/Manuals/Policies**: Familiarize yourself with the University's General Laboratory Safety Manual, Chemical Hygiene Plan, Biological Safety Manual, Radiation Safety Manual and Regulated Waste Manual. Every laboratory using hazardous chemicals, radioactive, or biological hazards must have a copy of the respective manuals in the lab or otherwise readily available. These manuals are readily available on the EHS website. Thoroughly review all applicable safety manuals with laboratory personnel.
- **Update Chemical Inventory annually and keep Safety Datasheets on files**. All laboratories are required to keep an updated copy of their chemical inventory on file, which must be made available to EHS upon request. Lab personnel must know how to get SDSs; either paper copies in the lab, or the electronic copies on a computer. Regardless of the system used, SDSs must be available at all times. More please see 3.3.2 Chemical Inventory of this Plan.
- **Complete risk assessment and then SOP**: Incorporate risk assessments when planning out experiments, and write Standard Operating Procedures before beginning new processes/operations. More please see Chapter 5.3 PHS SOP in this Plan.
- **Plan for emergencies** and know the location of emergency eyewash stations and safety showers, spill kits, fire extinguishers, and fire pull stations. In the event of a chemical spill which is beyond the capability of the laboratory personnel, notify EHS immediately after providing first aid and/or getting help.
    - During business hours (M-F/8-5) call 713-743-5858.
    - After hours call 911 on campus phone or 713-743-3333 to be routed to EHS staff on call.
- **Properly label** all chemical containers, including oil/water baths, squirt bottles, etc.
- **Properly label and dispose chemicals**. To request a pickup of chemicals, submit online UH Hazardous Waste Pickup Request Form. Disposal of all laboratory waste shall follow the procedures outlined in the "Regulated Waste Manual". A laboratory waste minimization program is also coordinated by EHS. Please consult the Regulated Waste Manual for detailed information.
- **Follow Other lab rules to ensure chemical safety:**
    1. **No smoking**.
    2. **Never work alone** with any hazardous chemicals/materials or operations.
    3. **Wear PPE and appropriate apparel**, including clothing that covers the legs, closed toe solid top shoes, and safety glasses; wear gloves and a lab coat when workingwith hazardous materials.
    4. **Follow additional PPE requirements** depending on the type of research being conducted.
    5. **Keep aisle ways clear.** Do not block access to emergency equipment or exits.

6. **Store chemicals in appropriate storage locations**. Do not store chemicals on floors and keep storage outside chemical cabinets to a minimum.
7. **No Food or Drink Rule Observed**. Eating, drinking and the application of cosmetics are not permitted in areas where hazardous chemicals are used. Never store food or drink in the same refrigerator with chemicals, biohazards or radioactive materials.
8. **No horseplay**. Practical jokes or other behavior that might confuse, startle, or distract another worker is not permitted.
9. **Mercaptans (thiols, sulfhydryl reagents)**. To avoid false reporting of natural gas leaks, EHS shall be contacted at 713-743-5858 when mercaptans will be used in a laboratory in such a manner that persons outside of the laboratory could smell the mercaptan and suspect a natural gas leak in the building. All experiments in which mercaptans are used must be performed in a chemical hood.
10. **Use proper equipment that is in good condition.** For example, never use chipped or cracked glassware. Shield pressurized or vacuum apparatus and safeguard against bumping or overheating. When inserting glass tubing into stoppers, lubricate the tubing and protect hands from being cut in the event the tubing slips and breaks.
11. **Mouth pipetting is not permitted.**
12. **Heat Sources Separated from combustibles.** Ignition sources include electrical outlets, lighting fixtures, switches, exposed machinery components, as well as open flames.
13. **Appropriate Clearance to Ceiling.** It is required that there is an 18-inch clearance to the ceiling to comply with NFPA codes for fire sprinkler systems and a 24-inch clearance in rooms which are not equipped with sprinklers.
14. **Electrical Circuit Loading and Cords**. Insufficient or overloading of electrical outlets must be avoided.
15. **Compressed Gas Cylinders Secured.** Compressed gas cylinders, regardless of their sizes, must be stored upright and secured to an unmovable surface by means of a chain link or strap (not string) to prevent them from tipping. The chain link or strap must be at approximately two thirds up the cylinder. Caps must be on the cylinders when cylinders are not in use and no regulator is attached, in order to protect the valves. More please see Appendix B Compressed Gas Cylinder Policy in General Laboratory Safety Manual.
16. **Minimize Trip Hazards.** Laboratories shall be maintained free of trip hazards. This includes items such as power cords on the floor, excessive equipment in the laboratory, and/or damaged flooring.

3.3.2 Chemical Inventory

All laboratories are **required** to keep an updated copy of their chemical inventory on file, which must be made available to EHS upon request. Chemical inventory must be maintained and verified annually. For each hazardous substance on their inventory, below information must be indicated on the chemical inventory: **CAS number, Chemical name, Physical state, Quantity, Amount and Chemical room location. Receipt Date is also required for peroxide forming materials such as sodium amide, diethyl ether, and isopropyl ether.** The Safety Data Sheets of the chemicals must be made readily available to all laboratory personnel.

Labs are required to include all hazardous materials in your inventory so the information is readily available to emergency responders and so that UH can provide accurate reports to federal and state agencies. The following examples are materials that required to be in the chemical inventory: all materials that are toxic, oxidizing, corrosive, reactive, carcinogenic, or flammable, as well as any liquids and gases under pressure including liquid nitrogen tanks and compressed air cylinders. However, many hazardous materials are excluded from the chemical inventory, per the table below. If you are unsure what to include, please contact EHS.

What to include in your inventory	What not to include
All chemicals and chemical products (except those listed to the right)	Retail products used and stored in amounts and frequencies typical to ordinary household usage.
All compressed and liquefied gases	Etiologic agents (bacteria, viruses, select agents, and toxins)
Lubricants, fuels, and oils (motor oil, gasoline, diesel, vacuum pump oil)	Biological culture media, agar, serum proteins, albumin
Aerosol lubricants	Enzyme preparations
Paints including spray-paints	Non-hazardous buffers
Pesticides and biocides	Radioactive materials (unless mixed with hazardous chemicals)
	Pre-packed test kits for medical labs
	Commercially packaged drugs in solid, final form (tablets, pills) for direct administration
	Commercial food, drugs and cosmetics, covered by the FDA
	Materials to be used within 1-2 days (“working solutions”)
	Hazardous waste

3.3.3 Housekeeping, Maintenance, and Inspections

General Housekeeping

It is the responsibility of all laboratory personnel to ensure that the laboratory is maintained in a clean and orderly state. Excessive storage of equipment, supplies, and chemicals can pose various hazards to laboratory personnel and other building occupants.

Laboratories shall be maintained in such a manner where there is at least 36 inches of clearance between obstructions to exit from the laboratory into the corridor. The door from the lab to the corridor must remain closed at all times. The corridors must have a minimum of 48 inches of clearance and shall be maintained free of obstructions to ensure clear egress to the nearest stairwell in the event of an emergency. Many times, emergency safety equipment i.e. safety showers and eyewashes are also located in the main corridors and this equipment shall be maintained free of any obstruction.

Inspections

EHS performs laboratory safety inspections routinely to ensure that adequate safety equipment is available and functioning, personal protection is available in use, chemicals are properly used and stored, SDSs are readily accessible and good housekeeping is being practiced. More frequent inspections may be performed by EHS due to laboratory accidents, near misses, or unsafe lab practices and/or procedures. Follow-up inspections will be performed as necessary, to confirm completion of corrective actions.

During routine surveys conducted by EHS, the safety representative will talk with the Principal Investigator or Designee as well as laboratory personnel to ensure they have no specific safety concerns. If the Principal Investigator or Designee or laboratory personnel raise concerns, the EHS safety representative will make every effort to address the issue either personally, or by way of an EHS Safety Manager, or the EHS Director.

Fire extinguishers shall be located inside all laboratories or, in some instances, a maximum of 75 feet from the laboratory. Extinguishers are inspected on a quarterly basis and maintained by the Fire Marshal's Office (FMO). Laboratory personnel shall routinely inspect for broken seals, damage, and low gauge pressure (depending on type of extinguisher). If problems are identified, repairs are requested by contacting FMO at 713-743-5858.

Internal housekeeping and chemical hygiene inspections shall be conducted by the Principal Investigator or Designee at least quarterly. Refer to the format used in the EHS inspections.

Repair

Facilities Management shall be contacted if safety equipment is malfunctioning.

- Non-Emergency Facility Service Request: submit a service order or track work order status, log in to AccessUH and click on Facility Request Self-Service (FIX-IT)
- Any Emergency Facility Service Request: call 713-743-4948 (FIX-IT)

Malfunctioning fume hoods must have the sash closed down completely and be marked “Do Not Use” if they are to be repaired. To re-start an “Out of Service” fume hood, contact EHS. Malfunctioning eyewashes and safety showers must be marked “Do Not Use". For repairs that haven’t been completed within five working days contact EHS for assistance.

3.3.4 Usage of laboratories

Work conducted in University of Houston is for research or instructional purposes. Work is laboratory scale in nature, and activities are conducted within the physical limitations of the laboratory facilities and safety equipment, especially local exhaust systems. EHS shall be informed by the Principal Investigator or Designee when chemical usage falls outside of typical laboratory scale operations.

3.3.5 Other University Safety Programs

Laboratory personnel who work with biological agents and radiation sources or radiation producing devices, are subject to the requirements of the University’s Biological Safety and Radiation Safety Programs, respectively. Further information on each is available at https://uh.edu/ehs/commons/manuals/ .

4.0 Chemical Usage Procedures

4.1 Understanding and Minimizing Chemical Exposures

It is prudent to understand and minimize all chemical exposures by any route, and to observe good laboratory practices by using an exhaust hood, wearing eye and hand protection, and a laboratory coat or apron. The cardinal rule for safety in working with hazardous substances is that all work with these materials in a laboratory shall be performed in such a way that they do not enter the body by any mode, including inhalation, injection, absorption or ingestion. Quantities of vapors or dust shall be prevented from entering the general laboratory atmosphere.

Under some circumstances, all chemicals can be hazardous. Even for substances of no known significant hazard, exposure must be minimized. For work with substances that present special hazards, special precautions must be taken. One shall assume that any mixture will be more hazardous than its most hazardous component. In the research laboratory where new preparations are constantly being developed, it is especially wise to maintain at least the same level of safe practice in the disposal of chemical wastes and residues as in the actual preparative procedures. All substances of unknown hazard must be considered hazardous until proven otherwise.

Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals have been adopted in addition to specific guidelines. These general hazards for handling chemicals in the laboratory may be classified broadly as physical and health.

Physical hazards include those of fire, explosion or electric shock. Other physical hazards arise from high or low pressure, such as cylinders of compressed gases and experimental vessels, cryogenic equipment, furnaces, refrigerators and glass apparatus.

Health hazards are associated with their health effects and may be sub-classified as acute or chronic. Acute hazards are those capable of producing prompt effects (such as burns, inflammation, or damage to eyes, lungs, or nervous system). Some chemicals are extremely dangerous in this respect and even a small amount can cause death or severe injury very quickly. Other toxicological effects of chemicals may be delayed or develop only after exposure over long periods of time and are referred to as chronic hazards.

4.2 Chemical Hazards Types

4.2.1 Physical Hazards

Flammability Hazard

A number of highly flammable materials (gases, liquids and solids) are in common use in campus laboratories. Flammable materials are substances that can ignite easily and burn rapidly. An UL-listed flammable storage cabinet must be used to store flammable materials. Quantities for

storage are based on flammable class and location within the building. Flame-resistant laboratory coats must be worn when working with pyrophoric materials and/or with procedures where a significant fire risk is present. These materials can constitute a significant immediate threat and must be treated with particular care, even though the use of these materials is fairly common in the laboratory setting. Particular attention must be given to preventing static electricity and sparks when handling flammable liquids. (Based on the Global Harmonized System (GHS) adopted by OSHA (1910.106(a)(19)), flammable liquid means any liquid having a flashpoint at or below 199.4
°F (93 °C)).

Reactivity Hazards
Reactive and explosive substances are materials that decompose under conditions of mechanical shock, elevated temperature, or chemical action, and release large volumes of gases and heat. Some materials, such as peroxide formers, may not be explosive, but may form explosive substances over time. These substances pose an immediate potential hazard and procedures which use them must be carefully reviewed. These materials must also be stored in a separate flame- resistant storage cabinet or, in many cases, in laboratory grade refrigerator or freezer that are designed for flammable and reactive chemicals. Pyrophoric chemicals are a special classification of reactive materials that spontaneously combust when in contact with air and require lab-specific training. Flame-resistant laboratory coats must always be worn when working with pyrophoric chemicals.

4.2.2 Health hazards

OSHA uses the following definition for health hazards:
The term “health hazard” includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

The major classes of “hazardous” and “particularly hazardous substances” and their related health and safety risks are detailed below and Chapter 5 Particularly Hazardous Substances (PHSs).

Corrosive Substances
As a health hazard, corrosive substances cause destruction of, or alterations in, living tissue by chemical action at the site of contact.

Major classes of corrosive substances include:

- Acids – e.g., sulfuric acid, nitric acid, hydrochloric acids, and hydrofluoric acid
- Bases – e.g., sodium hydroxide, potassium hydroxide and ammonium hydroxide
- Dehydrating agents – e.g., sulfuric acid, sodium hydroxide, phosphorus pentoxide and calcium oxide
- Oxidizing agents – e.g., hydrogen peroxide, chlorine, bromine, sodium nitrate, and potassium permanganate.

Symptoms of exposure for inhalation include a burning sensation, coughing, wheezing, laryngitis, shortness of breath, nausea, and vomiting. For eyes, symptoms include pain, blood shot eyes, tearing, and blurring of vision. For skin, symptoms may include reddening, pain, inflammation, bleeding, blistering and burns. As a physical hazard, corrosive substances may corrode materials they come in contact with and may be highly reactive with other substances. It is important to review information regarding the materials they may corrode, and their reactivity with other substances, as well as information on health effects. In most cases, these materials must be segregated from other chemicals and require secondary containment when in storage, specialty hoods, and exhaust ducting.

Irritants

Irritants are defined as non-corrosive chemicals that cause reversible inflammatory effects on living tissue by chemical action at the site of contact. A wide variety of organic and inorganic compounds, including many chemicals that are in a powder or crystalline form, are irritants. The most common example of an irritant may be ordinary smoke which can irritate the nasal passages and respiratory system. Consequently, eye and skin contact with all laboratory chemicals must always be avoided. Symptoms of exposure can include reddening or discomfort of the skin and irritation to respiratory systems.

Sensitizers

A sensitizer (allergen) is a substance that causes exposed people to develop an allergic reaction in normal tissue after repeated exposure to the substance. Examples of sensitizers include diazomethane, chromium, nickel, formaldehyde, isocyanates, arylhydrazines, benzylic and allylic halides, and many phenol derivatives. Sensitizer exposure can lead to all of the symptoms associated with allergic reactions or can increase an individual's existing allergies.

4.3 Hazardous Chemical Classification Systems

Chemical classification systems are designed to communicate hazards. The three most widely used classification systems are the OSHA Globally Harmonized System for Classifying and Labeling Chemicals (implemented under the OSHA Hazard Communication Standard), the National Fire Protection Association (NFPA) system of classifying the severity of hazards, and the Department of Transportation (DOT) hazard classes. These classification systems are used by chemical manufacturers when creating safety data sheets and chemical labels, therefore it is important that University of Houston laboratory personnel understand the basic elements of each classification system. These classification systems are provided in Appendix 3.

4.4 Controlling Chemical Exposures

Many chemicals can cause immediate health problems as well as long-term health effects. Examples include carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the

hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes. Hazardous chemicals (such as flammable liquids, compressed gases, and unstable water-reactive materials) can also pose inherent physical dangers.

There are four major routes of entry for a chemical to enter the body: inhalation, skin and eye contact, ingestion and injection. Five layers of controls for prevention of these various routes of entry include: elimination, substitution, engineering controls, administrative controls and personal protective equipment. Each route of entry a chemical can take to enter the body can be controlled in a number of ways, as explained below.

4.4.1 Inhalation Hazards

Inhalation of chemicals is the most common route of entry a chemical can take to enter the body. To avoid significant inhalation exposures, elimination and substitution are the best options to eliminate or minimize hazards. For example, substituting a less volatile or a less toxic chemical, or substituting a liquid or solid chemical for a gaseous one are the best means of control. If substitution is not practical, engineering control, such as ventilation, shall be used to lessen the chance of overexposure. The use of well-functioning local exhaust ventilation such as chemical fume hoods, vented glove boxes and other local exhaust systems are often required to minimize exposure to hazardous chemicals. Dilution ventilation may be used to reduce exposure to non-hazardous nuisance odors. For extremely toxic chemicals such as those classified as poisonous gases by State or Federal Department of Transportation (e.g., arsine, phosgene) the use of closed systems, vented gas cabinets, fail-safe scrubbing, detection or other stricter controls may be required.

Administrative controls can be utilized to reduce the risk of overexposure to hazardous chemicals. Some examples of administrative controls include:

- minimization of exposure time for individual laboratory personnel;
- restricted access to an area where a hazardous chemical is used;
- allowing a process that emanates nuisance odors to be done only after typical office hours, when most of the staff in the building have gone home; and,
- proper signage on laboratory doors to indicate special hazards within, a list of laboratory personnel who will be contacted in the event of an emergency, and appropriate telephone numbers. Contact EHS for assistance.

Finally, if engineering and administrative controls are not an option, the use of personal protective equipment (PPE) is a last resort to reduce inhalation exposures. If respirators are worn by laboratory personnel, requirements of the OSHA Respiratory Protection Standard (29 CFR 1910.134) must be met. This standard requires training on the proper use of respirators, medical surveillance to ensure the user is capable of wearing a respirator, and fit testing to ensure that the respirator fits properly. Laboratory personnel or his/her Principal Investigator or Designee shall contact EHS in the event that respiratory protection is needed to control exposures to hazardous chemicals. Annual fit testing will be required for continuous use.

4.4.2 Skin/Eye Contact Hazards

To reduce the risk of a chemical entering the body via skin and eye contact, substitution and appropriate engineering controls, shall be used as described above in "Inhalation Hazards." The more obvious means of preventing skin and eye contact is the wearing of personal protective equipment such as eye protection, face shields, gloves, appropriate shoes, lab aprons, lab coats, and other protective equipment appropriate to the hazard. Since the chemical resistivity of the different types of protective equipment varies significantly, the Principal Investigator or Designee shall consult SDS/MSDS of the chemical, glove manufacture or OSHA recommendation to ascertain that the protective equipment material is resistant to the chemical being protected against.

Administrative controls can be utilized to reduce skin/eye contact. Some examples of administrative controls include enforcement of policies pertaining to skin and eye protection, and discarding or repairing cracked or broken glassware.

4.4.3 Ingestion Hazards

Ingestion of chemicals is the least common route of entry into the body. Laboratory personnel can easily ingest chemicals into the body via contaminated hands if they are not washed prior to eating or smoking. Also, introducing contaminated objects (writing tools, cell phones) and/or hands in the mouth is another form of ingestion. Use engineering controls, such as isolating the hazardous substance so that minimal contact is required (e.g., use glove box), to help prevent exposures. Administrative controls such as restricting mouth pipetting, encouraging good personal hygiene, and designating a well-marked non-chemical area where eating, drinking and the application of cosmetics are permitted, is also beneficial in preventing chemical exposures via ingestion. Personal protective equipment, such as gloves, must be used as required.

4.5 Procurement of Chemicals

Hazards associated with various chemicals and gases vary widely. Understanding the hazards associated with a compound and minimizing the quantity used and stored in the laboratory will decrease the chance of injury. In order to minimize the presence of hazardous materials at the university, prudent PI and lab personnel should take below points into considerations before chemical purchasing. For example, labs should

- Check if the chemical is on the list of UH controlled chemicals.
- Order only needed amounts – Order an amount that will be used in the foreseeable future; don’t order larger quantities for the bulk discount. Having a larger amount on hand means that there is a greater potential for a harmful exposure (or, in the case of flammables, a fire), and may lead to additional disposal costs in the future.
- Order a less hazardous form of the same chemical – Use the logic below to help choose the least hazardous physical form that will work for your application.

  - Dilute solutions are generally safer than more concentrated solutions.
  - Aqueous solutions are generally safer to handle than powders requiring reconstitution.
  - Pellets, tablets, granules, or flakes are generally safer to handle than powders.
- Purchase the chemical in a safer container – Order chemicals in shatter-resistant containers or other containers that enhance employee safety.
  - Shatter-resistant containers – When ordering corrosives or highly flammable chemicals, choose containers that are less likely to break, such as metal, plastic, or PVC-coated glass. These options will reduce the risk of exposure or fire if the container is dropped.
  - Pre-weighed vials with rubber septum – When ordering hazardous powders, consider purchasing in a pre-weighed vial with a rubber septum. This eliminates the need to handle the powder, as the diluent can be injected directly into the container.
- Check the existing inventory before ordering – Maintain a chemical inventory so that lab members can check the availability of a chemical in the lab before ordering more.
- General guidelines for receiving a chemical package:
  - No chemical shipments shall be accepted without an adequate identifying label.
  - Delivery must be refused for leaking containers.
  - After receiving the package, promptly open the package and examine the chemical container for labels and container integrity.
  - If Safety Data Sheet (SDS) came with the package, save it in a binder for future reference or emergencies.

4.5.1 UH Controlled Chemicals

The UH MAPP Policy (Manual of Administrative Policies and Procedures) number 04.01.01, Purchase of Goods, Materials, and Supplies through the Purchasing Department, regulates the purchase of certain hazardous materials at University of Houston. This policy mandates that the EHS Hazardous-Regulated Materials Form (Replaces Addendum B Form) be used to obtain preapproval for hazardous materials purchases, including high risk hazardous chemicals. Under the leadership, advice and counsel of the UH Chemical Safety Committee (CSC), EHS has determined a list of UH controlled chemicals (Appendix 4) as shown in the following categories.

- DOT (US Department of Transportation)-Class 1.1A Explosives
- Select Department of Homeland Security Chemicals of Interest
- Peroxide Forming Chemicals Class A
- Highly Toxic Gases
- Chemicals with Radioactive Waste Concern
- Any Chemical Purchased in Quantities in Excess of 40 Gallons in a Single Order

EHS shall be contacted for the requisitions with hazardous chemicals listed on "UH Controlled Chemicals List". The completed EHS Hazardous-Regulated Materials Form, purchase requisition,

and related paperwork (vendor quote, etc.) must be scanned and emailed to ehs@uh.edu for EHS or CSC review and approval.

EHS shall also be contacted in advance of any acquisition of chemicals that will not be purchased but are to be transferred to the University of Houston from another university or organization.

4.5.2 Chemical Donations from External Organization

To ensure compliance with UHS Policy SAM 08.A.03 on Gift Acceptance and to establish proper safety procedures for accepting donated chemicals from external organization, all requests for chemical donations from external organizations must be directed to Environmental Health and Safety (EHS) for review and approval. This process upholds safety standards and promotes responsible management of chemical resources at University of Houston.

With limited exceptions, University of Houston will **not** accept chemical donations that meet any of the following criteria:

- Containers that have clear and apparent issues with content quality or container integrity;
- Original labels not intact;
- Expired* or within six months of expiration date;
- Chemicals that are in highly hazardous classes such as reactive & explosive**, highly toxic, radioactive and peroxide forming;
- Compressed gas cylinders including lecture bottles.

For chemicals not intended for research purposes, to initiate the donation process, contact EHS by emailing the completed Chemical Donation Receipt Request Evaluation Form to ehs@uh.edu. EHS will review the request and provide a decision accordingly.
For chemicals transfers intended for research purposes, the process must follow the alternative route of a Material Transfer Agreement (MTA). This ensures that all legal and compliance aspects are properly addressed.

*: If expiration date is not indicated on the chemical container, a Certificate of Analysis (CoA) for the lot/batch should be attached to the request evaluation form to indicate the manufacture/test date of the chemical.

**: Reactive &explosive chemicals include the following GHS and UN classification: Pyrophoric liquid or solid, Category 1; Pyrophoric gas; Explosives, Unstable or Divisions 1.1 - 1.3; Explosive when dry, or Explosive with or without air contact; Self-reactive or Organic peroxides, Type A or B; Self-heating, Category 1. Consult EHS if uncertain.

4.6 Receiving Chemical Package

General guidelines for receiving a chemical package:

- No chemical shipments shall be accepted without an adequate identifying label.
- Delivery must be refused for leaking containers.

- After receiving the package, promptly open the package and examine the chemical container for labels and container integrity.
- If Safety Data Sheet (SDS) came with the package, save it in a binder for future reference or emergencies.

4.7 Labelling and Signage

All University of Houston laboratory personnel who work with chemicals must be familiar with conventions used for hazard communication via signs and labels. This information is provided in EH06: General Laboratory Safety Orientation. Labeling requirements for all hazardous substances are summarized as follows:

As of December 1, 2015, all original labels provided by the manufacturers or distributors of hazardous chemicals will be required by OSHA to be Globally Harmonized System (GHS) compliant. GHS compliant labels will have pictograms, a signal word, hazard and precautionary statements, the product identifier, and supplier identification. These labels relay valuable information that can assist in hazard evaluation and control, and cannot be removed or defaced from the original container unless the contents have been altered or removed. Labels must be legible, in English, and prominently displayed.

Secondary containers (e.g. wash bottles, dropping bottles, vials, jars, centrifuge tubes, etc.) must be labeled with the identity of the substance and appropriate hazard warnings at a minimum. It is recommended that secondary use containers be labeled with the substance name, type of hazard, name of laboratory personnel who prepared the container, and date of preparation.

New synthesized compounds by laboratory operations must be labeled with the chemical name, name of laboratory personnel who prepared the container, date of preparation and appropriate hazard warnings based on the knowledge of the chemical and physical properties of that substance.

Time sensitive chemicals, such as Peroxide-forming materials must be dated when opened and disposed of through EHS within one year from the date of opening or by the manufacturer's expiration date, whichever occurs first. Consult the manufacturer's SDS to determine. These chemicals can degrade to form shock sensitive, highly reactive compounds and must be stored and labeled very carefully.

In a shared laboratory space, chemical storage cabinets, including general cabinets, storage cabinets under the fume hoods, flammable safety cabinets, and refrigerators, shelves, etc., should be labelled by PI's last name for easy identification. If chemicals are stored in a shared cabinet or area (e.g. fume hood or working bench), PI's last name should be labelled on each bottle of the chemical or chemical waste, including the secondary containers.

PIs in a shared laboratory/space should meet regularly to discuss safety expectations in the shared space and any concerns, such as housekeeping expectations, laboratory staffing

schedules, protocols for sharing chemicals and equipment, etc.

Laboratories shall prominently post below signage:

1. Notice to Employees HAZCOM Poster
2. No eating or drinking sign
3. Location signs for safety showers, eye washes, fire extinguishers, spill response kits, and first aid equipment
4. Chemical spill response procedures
5. Emergency evacuation plan
6. Emergency contact information
7. Warning signs at areas or equipment where special or unusual hazards exist

Radioactivity work areas, laboratories and containers of radioactive materials must be posted with appropriate warning signs. (See Radiation Safety Manual) Areas where human blood or other potentially infectious materials are stored or used must bear the universal biohazard symbol. Researchers working with or storing biosafety level 2 or higher organisms shall utilize the universal biohazard warning. Appropriate locations for biohazard signs include laboratory entrance, incubator, refrigerator, and waste containers. (See Biological Safety Manual)

Emergency postings shall also be placed on the laboratory electrical panel and emergency gas shut off valve. These two emergency cut-offs are utilized in emergency situations and shall never be obstructed with equipment or storage.

EHS prepares and posts laboratory door safety signs outside each laboratory. Contact EHS if the information on your door sign changes or needs to be updated.

4.8 Handling, Storage & Segregation of Chemicals

Hazards associated with various chemicals and gases vary widely. Understanding the hazards associated with a compound and minimizing the quantity used and stored in the laboratory will decrease the chance of injury. To minimize the presence of hazardous materials at the university,

chemicals should be ordered in the smallest quantity needed to conduct the work. Large quantities are not allowed (55 Gal Drum) unless approved by EHS before purchasing.

4.8.1 Chemical Handling

Proper PPE must be donned during any chemical handling process. Use secondary containment when transporting chemicals by placing the chemical being transported inside a protective container. For example, use polycoated bottles or bottle carriers for transporting chemicals that are in regular glass containers. Close caps securely and avoid storing chemical containers in hard to reach areas. Pour chemicals carefully, and never add water to concentrated acid or base.

Check the integrity of containers. Ensure that the container used is compatible with the chemical, for example hydrofluoric acid must not be stored in glass container.

Make sure all labels are legible. Label all secondary chemical containers with the chemical name (as it appears on the original label or SDS) and appropriate hazards at a minimum. (More information see 4.8 Labelling and Signage)

4.8.2 Chemical storage and segregation

The storage and segregation of all laboratory chemicals must adhere to the recommendations outlined in Appendix 5. Chemical Segregation and Incompatibilities Guidelines. Labs are required to maintain and verify an up-to-date chemical inventory within the lab space at least annually and conduct periodic cleanouts to promptly dispose of outdated, expired, or unidentified chemicals by submitting a waste pickup request to EHS.

General Guidelines for Laboratory Chemical Storage:

- Store chemicals (including gas cylinders) and chemical packages in an access restricted area.
- Keep chemicals away from heat sources, direct sunlight, and egress pathways.
- Assign each chemical a definite storage place and return to that place after each use.
- Provide secondary containment for liquids whenever possible.
- Label containers, and be sure container is compatible with the chemical.
- Keep containers closed when not in use.
- Do Not store materials on top of high cabinets where they will be hard to reach and see.
- Do Not store chemicals on the floor not even temporarily.
- Do Not store chemicals in a fume hood, except for certain toxic gases which can only be stored in a gas cabinet or fume hood.
- Do Not stack chemicals on top of each other.
- Do Not store chemicals (except cleaners) under sinks.
- Store flammable liquids in approved flammable liquid storage cabinets.
- Large quantities (> 1L) of flammable liquids shall be stored below eye level.
- Cold rooms, refrigerators, and freezers have additional requirements, particularly for flammables. If flammable liquids need to be stored in cold temperatures, store them in flammable storage refrigerator/freezer or explosion proof refrigerator/freezer. Never store flammable liquids in household refrigerators.
- Store highly toxic chemicals (e.g. cyanide salts) under conditions of satisfactory physical security, preferably in a locked cabinet.

General Guidelines for Laboratory Chemical Segregation:

Chemicals must be stored by compatibility, not by alphabetical arrangement. Compatibility information is available on the chemical's Safety Data Sheet (SDS). A quick and very general rule of thumb is to separate organics from inorganics, flammables from oxidizers (including gases as well as liquids), acids from bases, reactive from air or water, and acutely toxic chemicals from other chemicals.

Suggested chemical storage and compatibility lists can be found in a number of lab safety resources, e.g. Prudent Practices for Handling Hazardous Chemicals in Laboratories and UH Chemical Hygiene Plan (Appendix 5. Chemical Segregation and Incompatibilities Guidelines).

Secondary Containment:

Secondary containment is an effective tool to enhance the safe storage and segregation of hazardous materials by the following:

- Localize and contain spillage from defective or broken chemical containers.
- Prevent incompatible materials from mixing.

Ensure that secondary containment is sufficiently voluminous so that it can hold the contents of the inner containers should they break. In most cases, open-topped plastic secondary containment is satisfactory for hazardous material storage. EHS prepared "A Simple Guide for Use of Secondary Containment for Chemicals" to assist lab better utilize secondary containment for chemical storage

Specific Storage Requirements (More please see Appendix 5: Chemical Segregation and Incompatibilities Guideline)

Acids

- Never store acids directly on metal shelving.
- Segregate inorganic acids from organic acid and flammable and combustible materials.
- Segregate acids from bases.
- Segregate acids from active metals such as sodium, potassium, and magnesium.
- Store acetic acid as a flammable liquid. This is an organic (carboxylic) acid that will react if it comes in contact with an oxidizing acid. Keep acetic acid in flammable safety cabinet but also be kept in secondary containment in case of a spill.
- Nitric acid and hydrochloric acid may be stored in the same corrosive storage cabinet, but they must be kept in separate secondary containment. These can combine to form chlorine and nitrosyl chloride gases—both are toxic.
- Segregate acids from chemicals that could generate toxic or flammable gases upon contact, such as sodium cyanide, iron sulfide and calcium carbide.
- If hydrofluoric acid is in storage or in use, EH08: Hydrofluoric Acid Safety Awareness from EHS will be mandatory training for all lab workers. Contact EHS for more information. Hydrofluoric Acid SOP template is available on EHS webpage.
- Storage and use of perchloric acid shall follow the "UH Guideline for Perchloric Acid Usage and Storage" in Appendix 7. UH Guideline for Perchloric Acid Usage and Storage.

Bases

- Segregate bases from acids, metals, explosives, organic peroxides and easily ignitable materials.
- Do not store aqueous sodium and potassium hydroxide solutions in aluminum drip trays. These will corrode aluminum.

Flammable liquids

- Store in approved safety cans or cabinets.
- Segregate from oxidizing acids and oxidizers.
- Keep away from any source of ignition: heat, sparks, or open flames.
- Never store flammable liquids in a domestic refrigerator. Only certified flammable liquid refrigerators can be used to store flammable liquids.

Oxidizers

- Keep away from flammable and combustible materials.
- Keep away from reducing agents such as zinc, alkali metals, hydrazine, oxalic acid, and formic acid.

Cyanides and Azides

- Segregate from aqueous solutions, acids and oxidizers.
- Store in an unbreakable chemically resistant secondary containment (polyethylene or polypropalene).

Unstable Explosives

- Shall not be stored in the laboratory. Typical example is **Dry Picric Acid**. Contact EHS for further assistance.

Pyrophoric or Water-Reactive Substances

- If in original container store in a cool, dry place, making provisions for an airtight seal.
- Store in a glove box after the material has been opened.
- More please see Appendix 9. UH Guideline for Pyrophoric/Water-reactive Chemicals Usage and Storage.

Nanomaterials

- Please see Appendix 8. UH Guideline for Nanomaterials.

Light-Sensitive Chemicals

- Store in amber bottles in a cool, dry, dark place.

Peroxide-Forming Chemicals

- Store in the flammable cabinet with the other flammable materials.
- Peroxide-forming materials must be dated when opened and disposed of through EHS within one year from the date of opening or by the manufacturer's expiration date whichever occurs first. Consult the manufacturer's SDS to determine.
- Segregate from oxidizers and acids.
- Please see Appendix 11. UH Guideline for Peroxide Forming Materials .

Organic Peroxides

- store away from flammable materials.

Particularly Hazardous Substances (Solids)

- Store in general chemical storage, segregated from incompatibles. Ideally, they would be stored separately from other chemicals and easily identifiable within the laboratory. More please see Chapter 5.

Particularly Hazardous Substances (Liquids)

- The organic solvents and solutions (such as formaldehyde and chloroform) shall be stored in a flammable cabinet. Inorganic solutions & compounds shall be stored in general storage in secondary containment. More please see Chapter 5.

Low Toxicity Materials/Irritants

- Store in general chemical storage.

4.8.3 Cylinder handling and storage

Cylinder storage. Cylinders must be stored in well-ventilated areas with their protective caps screwed on and the cylinder secured (e.g. chained down) to reduce the chance of the cylinder being knocked over. For assistance in securing gas cylinders, call EHS at 713-743-5858. Do not store cylinders near heat or high traffic areas. Do not store flammables and oxidizers together. For example, carbon monoxide (CO) and nitrogen dioxide (NO_2) cannot store together. Do not store empty and full cylinders together. Storage of large quantities of cylinders must be done in an approved gas cylinder storage area. All cylinders in a lab are considered in use.

Cylinder handling. Use appropriate handcarts to move cylinders. Cylinders must be capped and secured to the cart during transport. Highly toxic gases shall not be moved through the corridors and passenger elevators, particularly during business hours. Always consider cylinders as fulland handle them with corresponding care. EH26: Compressed Gas Cylinder Safety training is mandatory for all UH laboratory personnel who handle compressed gases.

4.9 Transport of Chemicals

The following safety precautions must be taken for chemical transport:

- Chemicals must be transported upright in safety containers with secondary containment, or on a wheeled cart with a design capable of containing leakage or spillage and negotiating uneven surfaces (e.g. expansion joints or floor drains) without tipping the chemical container or cart.
- Chemicals shall be transported on freight elevators where possible.
- Chemical containers must be sealed during transport.
- Cylinders must be strapped to a hand truck specifically designed for that purpose and cylinder cover caps must be in place.

5.0 Particularly Hazardous Substances (PHS)

5.1 Definition

The Occupational Safety & Health Administration's (OSHA) Laboratory Standard (29 CFR 1910.1450 (e) (3) (viii), requires that provisions be made for employee protection for work with particularly hazardous substances. These include select carcinogens, reproductive toxins, and acutely toxic substances.

"Particularly Hazardous Substances" are defined as belonging to one of three groups.

1. Select carcinogens, acutely toxic chemicals, reproductive toxins and chemicals known to have undesirable biological effects.

2. Chemicals for which reliable toxicity information is not available, but are highly suspected to be a PHS because of their similarity in chemical structure or function to known toxic agents.

3. Chemicals which are explosive, or otherwise violently reactive such as pyrophorics and water-reactive materials.

Laboratories at UH should evaluate GHS-compliant Safety Data Sheets should treat chemicals as particularly hazardous if they have one or more hazard classification indicated below. If the chemical has a hazard classification shown in red, it is also considered "high risk".

Particularly Hazardous Substance (PHS)	Definition
Select carcinogens	Any substance that meets at least one of the following criteria: • GHS Carcinogenicity Category 1A or 1B or; • Regulated by OSHA as a carcinogen or; • Listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) or; • Listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer (IARC) Monographs or; • Listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens " by NTP
Reproductive Toxins	Chemicals that affect the reproductive capabilities including causing chromosomal damage (mutations) and adverse effect on fetal development (teratogenesis), include those listed as • GHS Category 1A or 1B for reproductive toxicity
Acute toxicity	The ability of a chemical to cause a harmful effect after a

	single exposure. Chemicals having high acute toxicity include the following GHS classifications • Acute Toxicity by Inhalation or Dermal Exposure Category 1 or 2 • Acute Toxicity by Oral exposure Category 1
Specific target organ toxicity (single exposure) (STOT-SE)	Specific target organ toxicity (single exposure) (STOT-SE) means specific non-lethal effects on organs or organ systems in the body following single exposure to a chemical. All significant health effects that can impair function, whether reversible or irreversible, occurring immediately after exposure or following a delay. Chemicals having STOT-SE **Categories 1** include the following GHS classification • Specific Target Organ Toxicity—Single Exposure — Category 1
Respiratory Sensitizer	Respiratory Sensitizer is a substance that will lead to hypersensitivity of airways following inhalation of the substance. Chemicals having Respiratory Sensitizer **Categories 1** include the following GHS classification • Respiratory Sensitizer — Category 1
Reactive & explosive chemicals	Reactive & explosive chemicals considered Particularly Hazardous (and High Risk) include the following GHS and UN classifications • Oxidizing liquid or solid, category 1 • In contact with water releases flammable gas — Category 1 or 2 • In contact with acids liberates (very) toxic gas • In contact with water liberates toxic gas • Reacts violently with water • Pyrophoric liquid or solid—Category 1 • Pyrophoric gas • Explosives—Unstable or Divisions 1.1—1.3 • Explosive when dry, or Explosive with or without air contact • Self-reactive or Organic peroxides—Type A or B • Self-heating category 1

5.2 Responsibilities

It is the responsibility of the Principal Investigator or Designee to ensure that PHS determination is conducted on all existing chemical inventories and on all future chemical purchases. Furthermore, prior to beginning work with a PHS, or once the PHS determination is made, Principal Investigator or Designee shall complete a laboratory-specific Standard Operating Procedures (SOP). Principal Investigator must ensure that laboratory personnel are trained, understand, and implement the procedures as directed in the SOP.

All laboratory personnel approved to work with a particularly hazardous substance shall be trained by Principal Investigator or Designee and strictly comply with that cautions and procedures. Contact Environmental Health and Safety (EHS) for assistance.

5.3 Laboratory-Specific SOP

The purpose of the Laboratory-specific SOP (Chemical guidelines and SOP templates see Appendix 6) is to ensure that all laboratory personnel are adequately trained and familiar with PHS's chemical/physical properties, health hazard information and toxicity data before the use of them. Procedures for containment, storage, and waste management shall be described in detail. Safety precautions shall be addressed including assignment of designated area, personal protective equipment, engineering controls, first aid procedures and spill procedures.

In addition to the general safety guidelines in Section 3.3 and throughout the Plan, special precautions are needed when handling these types of chemicals. A minimum set of guidelines that must be followed is listed below. The Principal Investigator or Designee must ensure that these and other precautions designed to minimize risk of exposure to these substances are taken.

- Quantities of these chemicals used and stored in the laboratory must be minimized, as shall their concentrations in solutions or mixtures.

- Work with carcinogens, reproductive toxins, acutely toxic or reactive & explosive chemicals must be performed within a functioning chemical fume hood, ventilated glove box, sealed system, or other system designed to minimize exposure. The exhaust air from the ventilation systems may require scrubbing before being released into the atmosphere. In all cases, work with these types of chemicals shall be done in such a manner that the OSHA permissible exposure limits or similar standards are not exceeded.

- Compressed gas cylinders that contain acutely toxic chemicals must be kept in ventilated gas cabinets. The toxic gases are defined as gases that cause significant acute health effects at low concentrations, have a National Fire Protection Association (NFPA) health rating of 3 or 4, have low occupational exposure limits, or are pyrophoric.

- The ventilation efficiency of the designated hood, glove box or gas cabinet, and the operational effectiveness of mechanical and electrical equipment used to contain or manipulate these special substances must be evaluated periodically by authorized trained personnel or manufacturer designated personnel at intervals determined by manufacturers. The interval of evaluating systems may vary depending on manufactures' specification.

- Each laboratory utilizing these substances must designate an area for this purpose and must sign or mark this area with an appropriate hazard warning. The designated area may be an entire laboratory, an area of the laboratory or a device such as a fume hood or glove box. The designated area shall be marked with a DANGER, specific agent, AUTHORIZED PERSONNEL ONLY or comparable warning sign.

- All laboratory personnel who work in a laboratory that has an area designated for use with carcinogens, reproductive toxins, acutely toxic or reactive & explosive chemicals must be trained about the deleterious effects of these substances as well as signs and symptoms regarding exposure to these substances, whether or not they actually work with the substance themselves. Training to ensure the safe handling and storage of these substances is required for those who use these materials. This training is the responsibility of the Principal Investigator or Designee and must be done prior to the use of any of these materials.

- Laboratory personnel working with these chemicals must have access to appropriate personal protective equipment and must be trained on how to properly utilize the safety equipment.

- Detection and/or monitoring equipment will be required in laboratories where chemicals (especially poisonous gases) with a high degree of acute toxicity, high flammability are utilized. The monitoring equipment must be connected to the fire alarm system to notify the occupants of the building. Monitoring equipment must be maintained and tested according to manufactory specifications. Any problems must be corrected as soon as possible or remove PHS from lab.

- All wastes contaminated with these substances must be collected and disposed of in a timely manner and appropriately as outlined in the Regulated Waste Manual. For special disposal information, call EHS at 713-743-5858 or email to ehs@uh.edu. If possible and as soon as practical, waste products shall be destroyed by a suitable, generally acceptable chemical procedure to lessen or eliminate their toxicity.

- The designated working area shall be thoroughly and appropriately decontaminated and cleaned at regular intervals determined by Principal Investigator or Designee. The interval may be as short as one day or as long as six months depending upon the frequency of usage and level of hazard.

- Special precautions to avoid release and exposure carcinogens, reproductive toxins, acutely toxic or reactive & explosive chemicals must be utilized. For instance, volatile substances must be kept cool and contained; gases must have properly functioning valves, check valves, regulators, containment which can withstand pressure buildup, and appropriate piping; and dispersive solids must be kept in closed containers, used in places with minimum air currents, and appropriate contact materials must be used to avoid static discharge.

- Emergency response planning for releases or spills must be clearly outlined in SOP by the Principal Investigator or Designee and included in the training of the laboratory personnel and others who may be affected in the building. EHS can be contacted for assistance.

5.3.1 Principal Investigator Approval

The written laboratory-specific SOP must be approved and signed by the Principal Investigator before working with PHS chemicals may begin. The entire PHS SOP shall be reviewed by the Principal Investigator or Designee for accuracy. These procedures shall be reviewed and changed at the time of any process change. Consultation with EHS is recommended to ensure that procedures and safety precautions are adequate. The laboratory-specific SOP, including the signature page with signatures by all involved personnel must be maintained by the Principal Investigator or Designee, and be submitted to EHS either electronically via the ehs@uh.edu or hard copy upon request. See available Chemical Guidelines and SOP Templates at https://uh.edu/ehs/labs/chemical-safety/guidelines-and-standard-operating-procedures/.

5.3.2 Lab Personnel Training

Laboratory personnel must be trained, understand, and implement the procedures as directed in the SOP. Additional employees may be added to an existing SOP, or an existing SOP may be approved for use in another laboratory. In these cases, the protocol form must still be reviewed by the Principal Investigator or Designee and approved for use for each additional employee. Copies of the completed SOPs with signature page (training document) shall be forwarded to EHS upon request.

6.0 Response to Non-compliance

Discrepancies discovered during routine inspection will be addressed in the following manner.

Step One - Verbal Notification:

If, during a routine evaluation or inspection, a problem involving chemical safety procedures is observed, a verbal violation will be provided. If upon receipt of a verbal violation, the laboratory personnel take immediate steps to correct the problem, then no further response regarding the discrepancy will be requested.

Any laboratory personnel who is not wearing proper attire or PPE will be asked to leave the laboratory immediately by EHS until the situation is corrected.

Step Two - Written Notification

Following the inspection, a written summary of the findings along with violations to address any remaining concerns, if applicable, will be sent to the PI responsible for thelaboratory. The PI will then be requested to respond in writing within 15 days and describe his/her plan to address any unresolved safety violations.

Step Three - Second Written Notification

A list of discrepancies will be maintained by the Environmental Health and Safety Department Staff and a follow-up may be conducted within 30 days of the inspection to determine if corrective actions were taken.

Step Four - Follow-up Inspection

If the follow-up inspection reveals that the same discrepancy exists, notification of this situation will be sent to both the PI and the Department Chair. The Director of EHS, depending on the nature of the concern, may present the issue to the appropriate Dean and other senior administration officials.

Any procedure causing a high or unacceptable exposure risk or IDLH, (immediately dangerous to life or health) to employees or laboratory personnel will be suspended immediately by EHS without regard to the above procedure.

7.0 Medical Consultation

An opportunity to receive medical consultation shall be provided under the following circumstances: if an employee develops any symptoms thought to arise from chemical overexposure; after an event such as a major spill, leak or explosion which may have resulted in an overexposure; or, if an overexposure is identified as the result of an evaluation of the facility by EHS.

These suspected or actual exposures requiring medical evaluation shall be treated as a regular Worker's Compensation claim. A “Supervisor’s First Report of Injury” form must be filled out and signed by the supervisor and submitted to the Risk Manager’s office within 24 hours.

Additional employee injury forms are required to be completed by the employee and filed with Risk Management within 48 hours.

Following notification of overexposure, arrangements for an appropriate medical examination by a medical provider within the University’s certified medical network, (Injury Management Organization) must be completed before the exposed individual may return to work. If an emergency situation exists, treatment at any hospital emergency center will be accepted. Any medical examination required shall be provided without cost to the employee provided the University’s workers compensation administrator determines the exposure is directed related to the employee’s employment.

Appendix 1. College/Department Chemical Safety Officer Responsibilities and Duties

Main responsibilities of a College or Departmental Chemical Safety Officers:	**Duties for each core responsibility:**	**Suggested ways to achieve success:**
1. Serve as a liaison and facilitate communication between their college/department and Environmental Health and Safe (EHS)	❖ Ensure the college/department is identifying and implementing safe work practices in their daily work ❖ Assess new safety and health hazards ❖ Directly address safety concerns (including escalation to college/department leadership or shutdown imminent health hazards) ❖ Communicate with principal investigators (PIs) and other college/departmental staff to ensure they understand their safety responsibilities, policies applicable to research, & are aware of environmental health and safety issues ❖ Notify EHS of new or existing operations that may warrant further investigation and/or monitoring ❖ Notify EHS of new or changing faculty space assignments, including faculty leaving the University	❖ Build relationships - Get to know the researchers in the college/department, have conversations to understand their safety concerns and hazardous activities ❖ Attend CSO/DSO Training - EHS provides annual training and other updates for CSOs/DSOs ❖ Connect with the EHS Safety Professionals - EHS staff members are available to answer questions, and to help problem solve
2. Maintain a working knowledge of the ongoing research	Be aware of relevant best practices, regulations, and policies	Attend CSO/DSO training Participate on college or departmental

Main responsibilities of a College or Departmental Chemical Safety Officers:	**Duties for each core responsibility:**	**Suggested ways to achieve success:**
activities in the college/department, and cultivate working relationships with key college/department personnel	Actively engage in safety improvement Be a visible advocate for safety in the college/department	safety committees Review Health and Safety Resources Review the University's Chemical Hygiene Plan - This document contains a great deal of information about many health and safety best practices Connect with the EHS Safety Professionals - EHS staff members are available to answer questions, help find additional resources, and to help problem solve
3. Promote safety training and identify training opportunities	Ensure PIs are aware of all required safety training for themselves and their research employees Coordinate general departmental training sessions for research employees Educate PIs and other researchers about the Chemical Hygiene Plan Ensure PIs provide regularly training their research personnel regarding lab-specific SOPs Survey the college/department for desired training courses/offerings and provide that information to EHS	Consult PIs about the potential hazards that can/have occurred within their areas of research, and suggest safety measures that mitigate these hazards to assist them in writing their SOPs Review EHS Training web page to learn about various training topics that must be covered and recorded Send PIs and other research personnel to EHS for available training Include information about college/department CHP in annual training for PIs and research personnel Include information about PIs responsibilities regarding SOP implementation in the lab during annual training/communications with PIs and research personnel Record minutes of training meetings you provide to department employees
4. Oversee the college/department safety audit program	Schedule periodic or random inspections of select laboratories and work areas in the college/department Check the physical set up for health and	Use the General Lab Safety checklist. EHS has developed a checklist to help labs prepare for audits. Check to ensure PIs have written copies of safety procedures

Main responsibilities of a College or Departmental Chemical Safety Officers:	Duties for each core responsibility:	Suggested ways to achieve success:
	safety issues, such as safe functioning of laboratory and safety equipment, and proper chemical storage and handling Check and ensure researchers are aware of and can access pertinent safety documents (e.g., lab-specific SOPs, SDSs) and that all required training records are current Monitor researchers as they perform lab procedures to ensure they follow SOPs accurately, use chemicals safely, keep safety equipment working and accessible, and manage wastes properly Ensure audit findings are being reviewed by PI/Lab Supervisors, and inform them of their responsibility to take action on noted deficiencies Ensure follow-up actions are taken on audit deficiencies	and protocols for their research Review the EHS Information and Training web page to refresh yourself with the safety training and documentation requirements for research laboratories Follow up on audits by: connecting with PIs to ask about progress and offering assistance to resolve deficiencies; schedule follow-up audits or consultations to review significant safety problems, and/or contact EHS for assistance Review the Chemical Hygiene Plan. This document provides information about laboratory safety requirements Review publications from related professional organizations (e.g., American Chemical Society, National AG Safety Database) for detailed information in a particular area of research
5. Facilitate and enable college/departmental safety committees	Attend Committee meetings Actively participate by researching and sharing suggestions for best practices Be open to new ideas	May lead, but must participate on departmental or college level safety committees Utilize this forum to share best practices and make decisions on recommendations to department and college leadership for safety improvements.

Appendix 2. UH Laboratory Dress Code Policy

Standard Practice

The University of Houston Chemical Hygiene Plan states in Section 3.2 "**Attire.** Legs and feet must be covered by closed-toe shoes, long pants or skirts which fully cover the legs (no sandals, open-toed shoes, or shorts), long hair must be confined and loose clothing and jewelry must be secured before beginning work. Wear a properly fastened lab coat or apron specific for the hazards of the procedures performed in the laboratory. This includes, but is not limited to, using flame resistant clothing for use with pyrophorics, acid resistant protection when working with acids (especially HF or other strong acids), and protective items when working with hot or cold materials. The Principal Investigator or Designee is responsible for enforcing the protective clothing needed."

Purpose and Scope

This policy applies to all Laboratory Personnel while working in a laboratory at the University of Houston. All leadership and management representatives of the department/area have the authority and responsibility to enforce this policy.

Definitions

- Closed-toe shoes are shoes that completely cover the feet and are well secured on to the foot.
- Long pants are trousers, slacks or pants that extend from the Laboratory Personnel's waist to the top of their shoes
- Long skirts are skirts or skorts that extend from the waist to the top of their shoes
- Lab coats are lightweight coats worn for the purpose of protecting Laboratory Personnel's skin and clothing from chemical splashes. The fiber content of a laboratory coat must be appropriate for the chemicals in use. Use all-cotton lab coats when working with flammable materials. Use flame-resistant (FR) lab coats when working with pyrophorics.
- Long hair is any length of hair that could become entangled in equipment or dangle into chemicals or flames during work.
- Loose clothing is items such as loose-fitting sleeves, scarves, sweatshirt drawstrings and other clothing items that could become entangled in equipment or dangle into chemicals or flames during work.
- Jewelry are items such as necklaces, earrings, bracelets, or watches that could become entangled in equipment or dangle into chemicals or flames during work.

UH LABORATORY DRESS CODE TRAINING RECORD*

PI Acknowledgement			
Name:		E-Mail:	
Signature:		Date:	
Office Phone:		Cell Phone:	

Trained Laboratory Personnel					
"I have read and understand the Laboratory Dress Code. I agree to fully adhere to its requirements. By signing below, I also acknowledge that I have received hands-on training for the appropriate lab dress."					
Last	First	PSID	Email	Signature	Date

*This document, including the signature page with signatures by all involved personnel shall be maintained by the Principal Investigator or Designee, and be submitted to EHS either electronically via the ehs@uh.edu or hard copy upon request.

Appendix 3. Hazardous Chemical Classification Systems

1. Globally Harmonized System for Classifying Chemicals

The Globally Harmonized System (GHS) is a world-wide system adopted by OSHA for standardizing and harmonizing the classification and labeling of chemicals. The objectives of the GHS are to:

- Define health, physical, and environmental hazards of chemicals;
- Create classification processes that use available data on chemicals for comparison with the defined hazard criteria (numerical hazard classification is based on a 1- 5 scale, 1 being the most hazardous and 5 being the least hazardous); and
- Communicate hazard information, as well as protective measures, on labels and Safety Data Sheet (SDS), formerly known as Material Safety Data Sheets (MSDS).

1.1 Safety Data Sheets

The SDS provides comprehensive information that is imperative for the safe handling of hazardous chemicals. Laboratory personnel shall use the SDS as a resource to obtain information about hazards and safety precautions. SDSs cannot provide information for hazards in all circumstances. However, the SDS information enables the employer to develop an active program of worker protection measures such as training on hazard mitigation. Chemical manufacturers are required to use a standard format when developing SDSs. The SDS will contain 16 headings which are illustrated in Table 1.

Table 1 – GHS Required Section of a Safety Data Sheet

1.	Identification of the substance or mixture and of supplier	**9.**	Physical and chemical properties
2.	Hazards Identification	**10.**	Stability and reactivity
3.	Composition/information on ingredients	**11.**	Toxicological information
4.	First aid measures	**12.**	Ecological information
5.	Firefighting measures	**13.**	Disposal considerations
6.	Accidental release measures	**14.**	Transport considerations
7.	Handling and storage	**15.**	Regulatory information
8.	Exposure controls/personal protection	**16.**	Other information

1.2 Chemical Labeling

The GHS standardized label elements, which are not subject to variation and must appear on the chemical label, contain the following elements:

- Symbols (hazard pictograms) are used to convey health, physical and environmental hazard information, assigned to a GHS hazard class and category;

- Signal Words such as “Danger" (for more severe hazards) or "Warning" (for less severe hazards), are used to emphasize hazards and indicate the relative level of severity of the hazard assigned to a GHS hazard class and category;
- Hazard statements (e.g., “Danger! Extremely Flammable Liquid and Vapor”) are standard phrases assigned to a hazard class and category that describe the nature of the hazard; and
- Precautionary statements are recommended measures that shall be taken to minimize or prevent adverse effects resulting from exposure to the hazardous chemical.

The GHS also standardizes the hazard pictograms that are to be used on all hazard labels and SDSs. There are 9 pictograms that represent several defined hazards, and include the harmonized hazard symbols which are intended to convey specific information about each hazard. Figure 1 illustrates these GHS hazard pictograms.

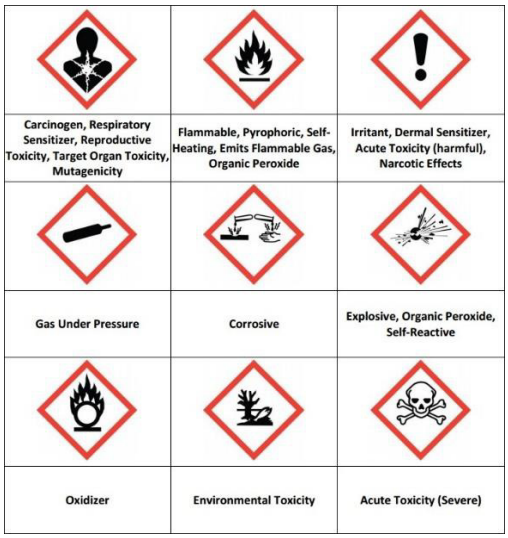

Figure 1 – GHS Hazard Pictograms

GHS labeling requirements are only applicable to chemical manufacturers, distributors, and shippers of chemicals. GHS labeling requirements are not required for chemicals being stored in a laboratory. However, since most chemicals stored in the laboratory have been purchased from a chemical manufacturer, the GHS labeling and pictogram requirements are very relevant and must be understood by laboratory employees. Figure 2 illustrates the GHS label format showing the required elements.

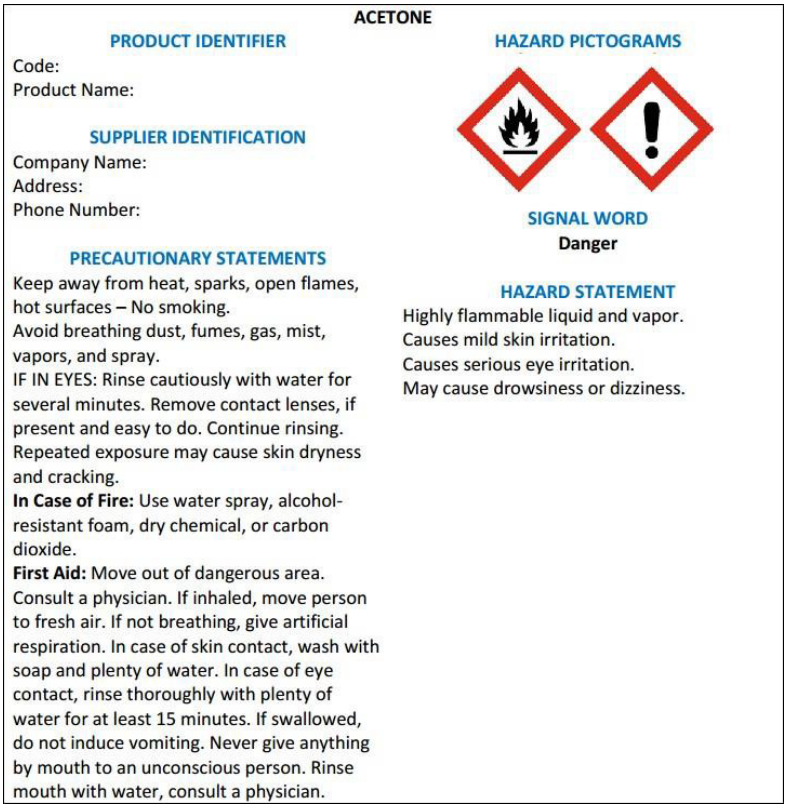

Figure 2 – GHS Label Format

As mentioned earlier, one of the objectives of GHS was to create a quantitative hazard classification system (numerical hazard classification is based on a 1 – 5 scale, 1 being the most hazardous and 5 being the least hazardous) based on physical characteristics such as flash point, boiling point, lethal dose of 50% of a population, reactivity, etc. Table 2 illustrates how the numerical hazard classification works for flammable liquids. More detailed information on GHS can be found on the OSHA website. (https://www.osha.gov/dsg/hazcom/global.html)

Table 2 – GHS Hazard Classification System for Flammable Liquids

Category	Criteria	Pictogram	Signal Word	Hazard Statement
1	Flash point < 23 °C Boiling point ≤ 35 °C		Danger	Extremely flammable liquid and vapor
2	Flash point < 23 °C Boiling point > 35 °C		Danger	Highly flammable liquid and vapor
3	Flash point ≥ 23 °C and < 60 °C		Warning	Flammable liquid and vapor
4	Flash point ≥ 60 °C and ≤ 93 °C		Warning	Combustible liquid
5	There is no Category 5 for flammable liquids			

2. National Fire Protection Association Rating System

The NFPA system uses a diamond-shaped diagram of symbols and numbers to indicate the degree of hazard associated with a particular chemical. This system was created to easily and quickly communicate hazards to first responders in the event of an emergency situation. These diamond-shaped symbols are placed on chemical containers to identify the degree of hazard associated with the specific chemical or chemical mixture. The NFPA system is a common way to identify chemical hazards and must be understood by laboratory employees. The NFPA 704 numerical rating system is based on a 0 – 4 system; 0 meaning no hazard and 4 meaning the most hazardous (note: this in contrast to the GHS system of 1 –5 where 1 is the most hazardous and 5 is the least hazardous). Figure 3 illustrates the NFPA hazard rating system and identifies both the hazard categories and hazard rating system. OSHA released the Comparison of NFPA 704 & HCS 2012 Labels QuickCard which can be found on the OSHA's website.

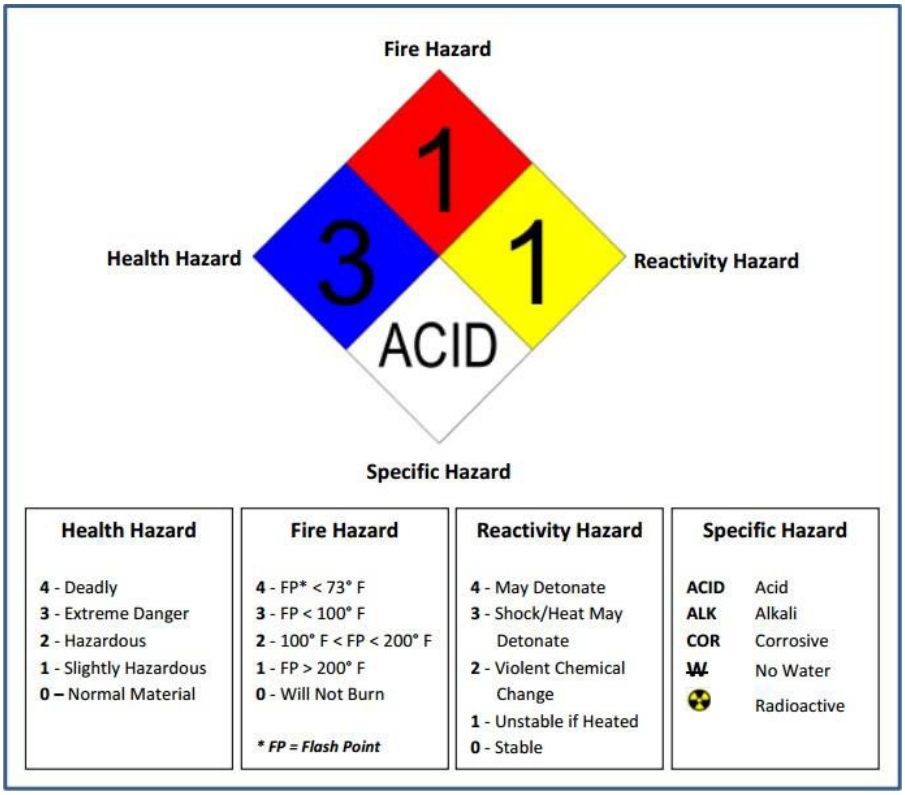

Figure 3 – NFPA Hazard Rating System

3. Department of Transportation Hazard Classes

The DOT regulates the transportation of all hazardous materials in the United States, and defines a hazardous material as any substance that has been determined to be capable of posing an unreasonable risk to health, safety, or property when transported in commerce. There are several methods that can be employed to determine whether a chemical is hazardous for transport, a few of which included:

- Reviewing the DOT Hazardous Materials Table (49 CFR 172.101);

- Reviewing the SDS, specifically Section 2: Hazardous Identification and Section 14: Transport Considerations, for the chemical being shipped, as detailed above in Section 1.1 of Appendix 2;
- Reviewing the chemical label and looking for hazard information detailed above in Section 1.2 of the Appendix 2; and
- Understanding the chemical and physical properties of the chemical.

All hazardous chemicals must be properly labeled by the chemical manufacturer or distributor before transportation occurs. Chemical containers stored in laboratories are not required to be labeled per DOT standards; however the nine DOT hazard classes are often seen on chemical containers and are discussed in Section 14 of GHS-formatted SDSs. The nine DOT hazard classes are illustrated below in Figure 4. Figure 4 only lists the primary hazard classes, the sub classes (e.g., Organic Peroxides, DOT Class 5.2) were omitted for stylistic purposes.

		
DOT Class 1 **Explosives**	**DOT Class 2** **Compressed Gases**	**DOT Class 3** **Flammable Liquids**
		
DOT Class 4 **Flammable Solids**	**DOT Class 5** **Oxidizers**	**DOT Class 6** **Poisons**
		
DOT Class 7 **Radioactive Materials**	**DOT Class 8** **Corrosives**	**DOT Class 9** **Miscellaneous**

Figure 4 – DOT Hazard Classes

Appendix 4. UH Controlled Chemical List

List #	Chemical Name	Synonyms	CAS Number[1]	Risk Assessment (**DOT**-Class 1.1A Explosive; **DHS**-Department of Homeland Security; **HTG**-Highly Toxic Gas, **PFC**-Class 1 Peroxide Formers, **RW**-Radiation Waste, **DUC**-Dual Use Chemical, **EPA**-Environmental Protection Agency)	The purchase of the chemical needs:
1	Barium azide		18810-58-7	DOT	CSC approval[4]
2	Diazodinitrophenol		4682-03-5	DOT	CSC approval[4]
3	Guanyl nitrosaminoguanylidene hydrazine	Guanyl nitrosaminoguanyltetrazene; Tetrazene	109-27-3	DOT	CSC approval[4]
4	Lead azide		13424-46-9	DOT	CSC approval[4]
5	Lead styphnate		15245-44-0	DOT	CSC approval[4]
6	Mercury fulminate		628-86-4	DOT	CSC approval[4]
7	1,3-Bis(2-chloroethylthio)-n-propane		63905-10-2	DHS	CSC approval[4]
8	1,4-Bis(2-chloroethylthio)-n-butane		142868-93-7	DHS	CSC approval[4]
9	1,5-Bis(2-chloroethylthio)-n-pentane		142868-94-8	DHS	CSC approval[4]
10	2-Chloroethylchloro-methylsulfide		2625-76-5	DHS	CSC approval[4]
11	Bis(2-chloroethylthio)methane		63869-13-6	DHS	CSC approval[4]
12	Bis(2-chloroethylthiomethyl)ether		63918-90-1	DHS	CSC approval[4]
13	Chlorosarin	o-Isopropyl methylphosphonochloridate; Agent GF	1445-76-7	DHS	CSC approval[4]

14	Chlorosoman	o-Pinacolyl methylphosphonochloridate	7040-57-5	DHS	CSC approval[4]
15	DF	Methyl phosphonyl difluoride	676-99-3	DHS	CSC approval[4]
16	Ethyl phosphonyl difluoride		753-98-0	DHS	CSC approval[4]
17	HN1 (nitrogen mustard-1)	Bis(2-chloroethyl)ethylamine	538-07-8	DHS	CSC approval[4]
18	HN2 (nitrogen mustard-2)	Bis(2-chloroethyl)methylamine	51-75-2	DHS	CSC approval[4]
19	HN3 (nitrogen mustard-3)	Tris(2-chloroethyl)amine	555-77-1	DHS	CSC approval[4]
20	Isopropylphosphonyl difluoride		677-42-9	DHS	CSC approval[4]
21	Lewisite 1	2-Chlorovinyldichloroarsine	541-25-3	DHS	CSC approval[4]
22	Lewisite 2	Bis(2-chlorovinyl)chloroarsine	40334-69-8	DHS	CSC approval[4]
23	Lewisite 3	Tris(2-chlorovinyl)arsine	40334-70-1	DHS	CSC approval[4]
24	Mustard gas (H)	Sulfur mustard; Bis(2-chloroethyl)sulfide	505-60-2	DHS	CSC approval[4]
25	O-Mustard (T)	Bis(2-chloroethylthioethyl)ether	63918-89-8	DHS	CSC approval[4]
26	Propylphosphonyl difluoride		690-14-2	DHS	CSC approval[4]
27	QL	o-Ethyl-o-2-diisopropylaminoethyl methylphosphonite	57856-11-8	DHS	CSC approval[4]
28	Sarin	o-Isopropyl methylphosphonofluoridate; Agent GB	107-44-8	DHS	CSC approval[4]
29	Sesquimustard	1,2-Bis(2-chloroethylthio)ethane	3563-36-8	DHS	CSC approval[4]
30	Soman	o-Pinacolyl methylphosphonoluoridate; Agent GD	96-64-0	DHS	CSC approval[4]
31	Tabun	o-Ethyl-N,N-dimethylphosphoramido-cyanidate; Agent GA	77-81-6	DHS	CSC approval[4]

32	VX	o-Ethyl-S-2-diisopropylaminoethyl methyl phosphonothiolate; Agent VX	50782-69-9	DHS	CSC approval[4]
33	Arsenic trichloride	Arsenous trichloride; Arsenic chloride; Arsenic butter	7784-34-1	DHS	EHS approval[3]
34	Diethyl methylphosphonite		15715-41-0	DHS	EHS approval[3]
35	Ethylphosphonothioic dichloride		993-43-1	DHS	EHS approval[3]
36	Isopropylphosphonothioic dichloride		1498-60-8	DHS	EHS approval[3]
37	Methylphosphonothioic dichloride		676-98-2	DHS	EHS approval[3]
38	N,N-(2-diethylamino)ethanethiol		100-38-9	DHS	EHS approval[3]
39	N,N-(2-diisopropylamino)-ethanethiol	N, N-diisopropyl-(beta)-aminoethane thiol	5842-07-9	DHS	EHS approval[3]
40	N,N-(2-dimethylamino)ethanethiol		108-02-1	DHS	EHS approval[3]
41	N,N-(2-dipropylamino)ethanethiol		5842-06-8	DHS	EHS approval[3]
42	N,N-Diethyl phosphoramidic dichloride		1498-54-0	DHS	EHS approval[3]
43	N,N-Diisopropyl phosphoramidic dichloride		23306-80-1	DHS	EHS approval[3]
44	N,N-Dimethyl phosphoramidic dichloride	Dimethylphosphoramido-dichloridate	677-43-0	DHS	EHS approval[3]
45	N,N-Dipropyl phosphoramidic dichloride		40881-98-9	DHS	EHS approval[3]
46	Nitrogen mustard hydrochloride	Bis(2-chloroethyl)methylamine hydrochloride	55-86-7	DHS	EHS approval[3]

47	o,o-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate	Amiton; Inferno; Agent VG	78-53-5	DHS	EHS approval[3]
48	Propylphosphonothioic dichloride		2524-01-8	DHS	EHS approval[3]
49	Thiodiglycol	Bis(2-hydroxyethyl)sulfide; 2,2'-Thiodiethanol	111-48-8	DHS	EHS approval[3]
50	Arsine	Arsenic anhydride; Agent SA	7784-42-1	DHS, HTG	EHS approval[3] when order in compressed gas
51	Chlorine pentafluoride		13637-63-3	DHS, HTG	EHS approval[3] when order in compressed gas
52	Diborane	Boroethane; Boron hydride	19287-45-7	DHS, HTG	EHS approval[3] when order in compressed gas
53	Dinitrogen tetroxide		10544-72-6	DHS, HTG	EHS approval[3] when order in compressed gas
54	Fluorine		7782-41-4	DHS, HTG	EHS approval[3] when order in compressed gas
55	Hydrogen cyanide	Hydrocyanic acid; Aero liquid HCN; Agent AC	74-90-8	DHS, HTG	EHS approval[3] when order in compressed gas
56	Hydrogen selenide	Selane	7783-07-5	DHS, HTG	EHS approval[3] when order in compressed gas
57	Nitric oxide		10102-43-9	DHS, HTG	EHS approval[3] when order in compressed gas
58	Nitrogen trioxide		10544-73-7	DHS, HTG	EHS approval[3] when order in compressed gas

59	Nitrosyl chloride		2696-92-6	HTG	EHS approval[3] when order in compressed gas
60	Oxygen difluoride		7783-41-7	DHS, HTG	EHS approval[3] when order in compressed gas
61	Phosgene	Carbonic dichloride; carbonyl dichloride; Agent CG; Agent DP	75-44-5	HTG	EHS approval[3] when order in compressed gas
62	Phosphine	Celphos; Delicia	7803-51-2	DHS, HTG	EHS approval[3] when order in compressed gas
63	Selenium hexafluoride		7783-79-1	DHS, HTG	EHS approval[3] when order in compressed gas
64	Stibine	Antimony hydride; Antimony trihydride	7803-52-3	DHS, HTG	EHS approval[3] when order in compressed gas
65	Sulfur tetrafluoride	Sulfur fluoride (SF4), (T-4)-; Sulfur fluoride	7783-60-0	DHS, HTG	EHS approval[3] when order in compressed gas
66	Tellurium hexafluoride	Tellurium fluoride	7783-80-4	DHS, HTG	EHS approval[3] when order in compressed gas
67	Cyanogen chloride	Chlorcyan; Agent CK	506-77-4	HTG	EHS approval[3] when order in compressed gas
68	Germanium tetrafluoride		7783-58-6	DHS	EHS approval[3] when order in compressed gas
69	Hydrogen sulfide	Sewer gas; Stink damp	7783-06-4	DHS	EHS approval[3] when order in compressed gas
70	Hydrogen fluoride (anhydrous)		7664-39-3	DHS	EHS approval[3] when order in

					compressed gas
71	Tungsten hexafluoride	Tungsten fluoride	7783-82-6	DHS, HTG	EHS approval[3] when order in compressed gas
72	Bromine trifluoride		7787-71-5	DHS, HTG	EHS notification
73	Chlorine trifluoride		7790-91-2	DHS, HTG	EHS approval[3] when order in compressed gas
74	Phosphorus trichloride		7719-12-2	DHS, HTG	EHS notification[2]
75	Trifluoroacetyl chloride		354-32-5	DHS, HTG	EHS approval[3] when order in compressed gas
76	Titanium tetrachloride	FM	7550-45-0	DHS, HTG	EHS notification[2]
77	Methylisocyanate	Methyl carbylamine	624-83-9	HTG	EHS notification[2]
78	Nickel carbonyl		13463-39-3	HTG	EHS notification[2]
79	Nitrogen dioxide		10102-44-0	HTG	EHS approval[3] when order in compressed gas
80	Phosphorus oxychloride	Phosphoric chloride	10025-87-3	HTG	EHS notification[2]
81	Butadiene	1,3-Butadiene; Biethylene	106-99-0	PFC	EHS notification[2]
82	Chloroprene	2-Chlorobuta-1,3-diene	126-99-8	PFC	EHS notification[2]
83	Divinyl acetylene	1,5-Hexadien-3-yne	821-08-9	PFC	EHS notification[2]
84	Isopropyl ether	Diisopropyl ether	108-20-3	PFC	EHS notification[2]
85	Potassium metal		7440-09-7	PFC	EHS notification[2]
86	Potassium amide		17242-52-3	PFC	EHS notification[2]
87	Sodium amide	Sodamide	7782-92-5	PFC	EHS notification[2]
88	Tetrafluoroethylene	Perfluoroethene; Perfluoroethylene	116-14-3	PFC	EHS notification[2]
89	Vinylidene chloride	1,1-Dichloroethylene; 1-1-DCE; VDC	75-35-4	PFC	EHS notification[2]
90	Thorium		7440-29-1	RW	EHS approval[3]

91	Thorium containing chemicals			RW	EHS approval[3]
92	Uranium		7440-61-1	RW	EHS approval[3]
93	Uranium containing chemicals			RW	EHS approval[3]
94	Uranyl acetate		6159-44-0	RW	EHS approval[3]
95	Uranyl formate		16984-59-1	RW	EHS approval[3]
96	Uranyl nitrate		13520-83-7	RW	EHS approval[3]
97	Boron tribromide	Borane, tribromo	10294-33-4	DHS	EHS notification[2]
98	Boron trichloride	Borane, trichloro	10294-34-5	DHS	EHS notification[2]
99	Boron trifluoride	Borane, trifluoro	7637-07-2	DHS	EHS notification[2]
100	Bromine chloride		13863-41-7	DHS	EHS notification[2]
101	Carbonyl fluoride	Carbon oxyfluoride; Fluophosgene	353-50-4	DHS	EHS notification[2]
102	Cyanogen	Ethanedinitrile; Carbon nitride; Dicyan	460-19-5	DHS	EHS notification[2]
103	Dichlorosilane	Silane, dichloro-	4109-96-0	DHS	EHS notification[2]
104	Germane	Germanium tetrahydride; Germanium hydride	7782-65-2	DHS	EHS notification[2]
105	Hexafluoroacetone	6FK	684-16-2	DHS	EHS notification[2]
106	Methylchlorosilane		993-00-0	DHS	EHS notification[2]
107	Perchloryl fluoride	Chlorine oxyfluoride; Chlorine fluoride oxide; Trioxychlorofluoride	7616-94-6	DHS	EHS notification[2]
108	Silicon tetrafluoride	Perfluorosilane	7783-61-1	DHS	EHS notification[2]
109	Sodium cyanide	Cyanogran; Cymag	143-33-9	DUC	EHS notification[2]
110	Potassium cyanide		151-50-8	DUC	EHS notification[2]
111	Methylene Chloride	Dichloromethane, DCM	75-09-2	EPA	EHS approval[3]

[1]**CAS Number**- The Chemical Abstract Service assigns CAS Numbers, a unique numerical identifier, to every chemical substance described in open scientific literature. The registry maintained by CAS is the authoritative collection of disclosed chemical substance information. To determine whether the chemical you intend to purchase is restricted by UH, find the CAS number. This is different from the Catalog or Product numbers which vary by supplier. CAS numbers can always be found on the Safety Data Sheet. Once found, search the list above using the Find feature to see whether your chemical's CAS number is listed.

[2]**EHS notification**: PI/Requestor will be required to complete the Pre-Approval Form for Requisitions with EHS Hazardous/Regulated Materials, purchase requisition. EHS will document the related information and approve PI/requestor the same day the purchase request is received.

[3]**EHS Approval:** PI/Requestor will be required to complete the Pre-Approval Form for Requisitions with EHS Hazardous/Regulated Materials, purchase requisition**.** EHS will contact the PI the same day the purchase request is received for additional information to determine if any further action on the chemical. The purchase of the chemical may be exempt from the approval process due to physical state, concentration, quantity, or properties of the gas mixture after EHS's analysis.

A. For exempt cases, Action is downgraded to EHS notification.
B. For non-exempt cases, EHS will arrange an in-person visit to discuss the safety requirements with the PI/Requestor. Based on discussion, PI/Requestor proposes the safety plan and submits it to EHS for review and approval.
C. For the repeated order, if there is no change from previously approved order, Action will be downgraded to EHS notification.

[4]**CSC Approval:** PI/Requestor will be required to complete the Pre-Approval Form for Requisitions with EHS Hazardous/Regulated Materials, purchase requisition. EHS will contact the PI the same day the purchase request is received for additional information. EHS will arrange an in-person visit to discuss the safety requirements with the PI/Requestor. Based on discussion, PI/User will propose the safety plan and submit to EHS for pre-review and Chemical Safety Committee (CSC) for final review and approval.

Appendix 5. Chemical Segregation and Incompatibilities Guidelines

Class of Chemicals	Examples	Recommended Storage Method	Incompatible Materials – ALWAYS REFER TO SDS	Possible reactions if mixed
Corrosives Organic Acids and Acid Chlorides 	formic acid, acetic acid, propionic acid, butyric acid, acetic chloride dichlordimethylsilane Trifluoroacetic Acid, Trichloroacetic Acid	• Flammable acids should be stored in a flammable cabinet with a secondary containment. • Non flammable acids should store in a separate, lined/protected acid storage cabinet, or in deep corrosion- resistant spill trays. • Keep away from potential water sources (e.g. under sinks). DO NOT store acids directly on metal shelves. • ALWAYS STORE BELOW EYE LEVEL.	Flammable liquids, flammable solids, bases, oxidizers, and Inorganic acids Acid chlorides must be separated from amines.	HEAT, GAS GENERATION, VIOLENT REACTIONS
Corrosives Inorganic Acids 	Mineral Acids – Hydrochloric Acid, Hydrofluoric Acid, Phosphoric Acid, Sulfuric Acid, Chromic Acid, Perchloric Acid, Nitric Acid, Hydrobromic Acid	Store in a separate, lined/protected acid storage cabinet, or in deep corrosion- resistant spill trays. Keep away from potential water sources (e.g. under sinks). DO NOT store acids directly on metal shelves. ALWAYS STORE BELOW EYE LEVEL.	Flammable liquids, flammable solids, bases, organic acids, oxidizers, and poisons	HEAT, GAS GENERATION, VIOLENT REACTIONS
Corrosives Bases/Caustics 	Ammonium Hydroxide, Sodium Hydroxide (caustic soda), Potassium Hydroxide (caustic potash)	Store in a separate storage cabinet or segregate with a deep, corrosion-resistant spill tray. Keep away from potential water sources (e.g. under sinks). ALWAYS STORE BELOW EYE LEVEL	Flammable Liquids, Flammable Solids, Acids, Oxidizers, and poisons	HEAT, GAS GENERATION, VIOLENT REACTIONS

Explosives 	Ammonium Nitrate, Nitro Urea, Sodium amide, Trinitroaniline, Trinitroanisole, Trinitrobenzene, Trinitrophenol/Picric acid, Trinitrotoluene (TNT), Trinitrobenzoic Acid, azides, perchlorates.	Store in a secure, cool, dry location away from all other chemicals. Do not store in an area where they can fall.	All other chemicals KEEP AWAY FROM HEAT AND IGNITION SOURCES SUCH AS DIRECT SUNLIGHT, HOT SURFACES, OPEN FLAMES, AND SPARK SOURCES.	EXPLOSION HAZARD
Flammable Liquids 	Acetone, Benzene, Diethyl Ether, Methanol, Ethanol, Toluene, Hexanes	Store all except small working quantities in a flammables storage cabinet or an approved flammable storage refrigerator (if necessary).	Acids, Bases, Oxidizers, Poisons KEEP AWAY FROM HEAT AND IGNITION SOURCES SUCH AS HOT SURFACES, DIRECT SUNLIGHT, OPEN FLAMES, AND SPARK SOURCES.	FIRE HAZARD, HEAT, VIOLENT REACTIONS
Flammable Solids 	Phosphorus, Magnesium, Carbon	Store in a separated cool, dry area away from oxidizers and corrosives.	Acids, Bases, Oxidizers, Poisons KEEP AWAY FROM HEAT AND IGNITION SOURCES SUCH AS HOT SURFACES, DIRECT SUNLIGHT, OPEN FLAMES, AND SPARK SOURCES.	FIRE HAZARD, HEAT, VIOLENT REACTIONS
Peroxide Forming Chemicals	Diethyl Ether, Tetrahydrofuran, Dioxane	Store in an NFPA approved flammables storage cabinet. ALL PEROXIDE FORMING CHEMICALS MUST BE DATED UPON RECEIPT AND OPENING.	Acids, Bases, Oxidizers, Poisons KEEP AWAY FROM IGNITION SOURCES	EXPLOSION HAZARD
Oxidizers 	Sodium Hypochlorite, Benzoyl Peroxide, Potassium Permanganate, Potassium Dichromate, Peroxides, Perchlorates, Chlorates, Nitrates, Bromates, Superoxides	Store in a deep spill containment tray inside a non-combustible cabinet, separate from flammable or combustible materials and reducing agents. Store inorganic oxidizers and organic peroxides separate from each other via secondary containment (e.g. trays).	Reducing agents, flammables, combustibles, organic materials, corrosives; VERY STRONG OXIDIZERS SHOULD BE STORED IN GLASS OR INERT CONTAINERS. DO NOT USE CORKS OR RUBBER STOPPERS.	FIRE HAZARD, TOXIC GAS GENERATION

Water Reactive Materials	Sodium metal, Potassium metal, Lithium metal, Hydrides such as Lithium Aluminum hydride or Sodium Hydride, Borohydrides	Store in a cool, dry location away from potential water sources (e.g. sprinkler systems, under sinks). Examples of suitable locations include desiccators or glove boxes filled with dry gases. LABEL LOCATION OF STORAGE AREAS AS "WATER REACTIVE CHEMICALS." MANY WATER REACTIVE CHEMICALS ARE FLAMMABLE SOLIDS. IF FLAMMABLE SOLID, STORE AS SUCH. IF NOT, STORE SEPARATELY FROM ALL OTHER CHEMICALS.	Aqueous Solutions, Oxidizers	HEAT, VIOLENT REACTIONS
Reducing Agents	Lithium Aluminum Hydride, Sodium Amalgam, Sodium Borohydride, Diisobutyl Aluminum Hydride, Formic Acid, Oxalic Acid	Store in a deep spill containment tray inside a non-combustible cabinet separate from oxidizers.	Oxidizers, Arsenic, Selenides	FIRE HAZARD, TOXIC GAS GENERATION

Flammable Compressed Gases 	Methane, Acetylene, Propane	Store in a cool, dry area away from oxidizing gases. Securely strap or chain cylinders. DO NOT STORE LECTURE SIZED GAS CYLINDERS IN CABINETS WITH HAZARDOUS LIQUIDS.	Oxidizing and Toxic Compressed Gases, Oxidizing Solids	FIRE HAZARD AND EXPLOSION HAZARD
Oxidizing Compressed Gases 	Oxygen, Chlorine, Bromine	Store in a cool, dry area away from flammable gases and liquids. Securely strap or chain cylinders. DO NOT STORE LECTURE SIZED GAS CYLINDERS IN CABINETS WITH HAZARDOUS LIQUIDS	Flammable Gases	FIRE HAZARD AND EXPLOSION HAZARD
Poisonous Compressed Gases 	Carbon Monoxide, Hydrogen Sulfide	Cylinders containing the compressed gases listed in this section must be kept in a continuously, mechanically ventilated enclosure.	Flammable and/or oxidizing gases	RELEASE OF TOXIC GAS, VIOLENT REACTIONS
Inert Compressed Gases 	Nitrogen, Helium, Argon	Store in a cool, dry area. Securely strap or chain cylinders. DO NOT STORE LECTURE SIZED GAS CYLINDERS IN CABINETS WITH HAZARDOUS LIQUIDS	Refer to SDS	REFER TO SDS

Appendix 6. Chemical Guidelines & SOP Templates

Standard Operating Procedures (SOPs) describe safe handling procedures for various chemical hazard classes and some commonly used chemicals. Chemicals identified as Particularly Hazardous Substances require a customized, laboratory-specific SOP. Reference: UH Chemical Hygiene Plan, Chapter 5.

The purpose of the Guidelines describes safe handling for various chemical hazard classes and some commonly-used chemicals to ensure that all laboratory personnel are adequately trained and familiar with PHS' chemical/physical properties, health hazard information and toxicity data before their use. Procedures for containment, storage, and waste management shall be described in detail in the lab-specific SOP.

The Principle Investigator or Designee must ensure that these and other precautions designed to minimize risk of exposure to these substances are taken. The guidelines were created by the Department of Environmental Health and Safety with the goal of complying with 29 CFR 1910.1450 (e)(3)(i) and educating the campus community on the safe use of the PHS.

The Department of Environmental Health & Safety (EHS) has also established the Standard Operating Procedure (SOP) system to facilitate the creation of SOPs within the UH community. The information provided is intended to be accurate and helpful, but it should not be considered exhaustive. The provided document(s) are not comprehensive in nature and should not be considered complete until the PI completes all relevant sections. The template is provided as a tool, which can be used by the Principal Investigator (PI) to create an SOP specific to the processes present in their lab. Training document page is used to document PI-led training for laboratory-specific procedures involving certain chemicals and procedures.

Chemical Guidelines & SOP Templates - University of Houston (uh.edu)

Appendix 7. UH Guideline for Perchloric Acid Usage and Storage

Please download the Guideline and SOP template on this weblink:
Chemical Guidelines & SOP Templates - University of Houston (uh.edu)

Appendix 8. UH Guideline for Nanomaterials

Please download the Guideline and SOP template on this weblink:

Chemical Guidelines & SOP Templates - University of Houston (uh.edu)

Appendix 9. UH Guideline for Pyrophoric Water-reactive Chemicals

Please download the Guideline and SOP template on this weblink:
Chemical Guidelines & SOP Templates - University of Houston (uh.edu)

Appendix 10. UH Guideline for Chemotherapy and Other Hazardous Drugs Safe Use

Please download the Guideline and SOP template on this weblink:
Chemical Guidelines & SOP Templates - University of Houston (uh.edu)

Appendix 11. UH Guideline for Peroxide Forming Materials

Please download the Guideline and SOP template on this weblink:
Chemical Guidelines & SOP Templates - University of Houston (uh.edu)