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Office of the Vice President for Research, Economic Development, and Knowledge Enterprise

CHEMICAL HYGIENE PLAN

THE UNIVERSITY OF TEXAS AT SAN ANTONIO

OFFICE OF RESEARCH INTEGRITY

LABORATORY SAFETY DIVISION

01-08-2019

REVIEW PAGE

This original version of this procedure manual has been reviewed for regulatory compliance and best management practices by the undersigned individuals and is hereby adopted for use and compliance by all employees at all University of Texas at San Antonio owned or operated facilities.

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This plan represents a significant rewrite. The January 8, 2019 version replaces the May 17, 2011 version.

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I. INTRODUCTION

A. OVERVIEW

Research with chemicals in laboratories can pose an increased risk to personnel that work there. UTSA is held to state and federal regulations defining the handling, use and disposal of hazardous chemicals. In addition, UTSA develops site specific plans and procedures that support the diverse research at the institution and the unique location of UTSA situated over the Edwards aquafer. This plan, and the safety committees that support research, are part of overall collaborative efforts between administration and faculty who strive to create a positive safety culture at the institution.

B. PURPOSE

The University of Texas at San Antonio (UTSA) is committed to providing a safe and healthy working environment for all faculty, staff and students in accordance with http://www.utsa.edu/hop/chapter9/most specifically in HOP 9.5 - Occupational Safety and Health and HOP 9.6 - Compliance with the Texas Hazard Communication Act. The Chemical Hygiene Plan (CHP) establishes the formal written practices for protecting all UTSA personnel and visitors from adverse health and safety hazards associated with the handling of, and potential exposure to, hazardous chemicals. The Chemical Hygiene Plan, in combination the Institutional Biosafety Plan, Radiation Safety Plan, Laser Safety Plan and X-Ray Safety Plan, should be used as a resource in developing a safe culture in research laboratories across campus.

C. SCOPE

This plan was developed by the Laboratory Safety Division which is part of the Office of Research Integrity located under the Vice President for Research, Economic Development and Knowledge Enterprise and written with reference to pertinent federal, state and local regulatory requirements. Regulatory agencies referenced include the Occupational Health and Safety Administration (OSHA) the Drug Enforcement Administration (DEA), the Environmental Protection Agency (EPA), the Texas Department of State Health Services (TDSHS), the Texas Commission on Environmental Quality (TCEQ), the Edwards Aquifer Authority (EAA), and the San Antonio Water System (SAWS).

The plan applies to all UTSA operated (leased or owned) facilities and equipment (including vehicles). It also applies to any UTSA employee, volunteer or student worker who works directly with chemicals, or is in close proximity to anyone conducting research using chemicals.

The Chemical Hygiene Plan outlines safe practices and procedures for research and educational laboratories. It is not intended to be a fully comprehensive reference but rather a starting reference. There may be chemicals, procedures and other circumstances in each laboratory that present unique or unusual hazards not addressed here. The Principal Investigator or supervisor of the respective laboratory should address unique hazards associated with specific research projects with specific operating procedures developed with the full support of the Laboratory Safety Division. Questions can be addressed to the Interim Laboratory Safety Manager who also serves are the Chemical Hygiene Officer at 210 458 -8515.

II. REGULATORY REQUIREMENTS

A. HAZARD COMMUNICATION AND THE TEXAS HAZARD COMMUNICATION ACT

In Texas, the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard applies to private-sector businesses only. To protect public-sector employees, the Texas legislature passed the Texas Hazard Communication Act in 1985. The law, which was revised in 1993, is also known as the Public Employer Community Right-to-Know Act and can be found in the Texas Administrative Code 25 TAC § 295 or the Texas Health & Safety Code Title 6, Chapter 502 – Hazard Communication Act. It requires public employers to provide their employees with information on hazardous chemicals to which they may be exposed in the workplace. Requirements under the act include compiling and maintaining workplace chemical lists, maintaining Safety Data Sheet (SDS) and informing employees of the hazards associated with the chemicals they use. The law is similar to OSHA's Hazard Communication Standard but is enforced by the Texas Department of State Health Services, Division of Regulatory Services, Enforcement Unit.

The Texas Hazard Communication Act applies to public schools, colleges and universities in Texas. Chemicals in a laboratory under the direct supervision or guidance of a technically qualified individual may be exempt if:

- labels on incoming containers of chemicals are not removed or defaced
- the laboratory supervisor complies with SDS and training requirements
- the laboratory is not used primarily to produce hazardous chemicals in bulk for commercial purposes.

Otherwise, all requirements of the act apply. Consult with the Laboratory Safety Manager to see if any exemptions may apply to a specific laboratory.

1. Requirements

1. **Container Labels**: Hazardous chemical containers must have a label that identifies the hazardous chemical and lists the appropriate hazard warnings.
    a. Primary or Original Containers: A label on an existing container may not be removed or defaced unless it is illegible or inaccurate or does not conform to labeling requirements.
    b. Secondary Containers: When transfers are made from the primary chemical container (stock bottle) to other containers, the secondary containers should be labeled with:
        i. the name of the chemical (as it appears on the SDS) and
        ii. the appropriate hazard warnings unless it is used immediately by the individual who made the transfer.
2. **Safety Data Sheets (SDS):** The Safety Data Sheet (SDS) are an extensive compilation of chemical hazard and safe-handling information. Each sheet provides most of the information an employee needs to work with a chemical safely. Chemical manufacturers or distributors must develop an SDS for each hazardous chemical they produce or distribute and are required to provide an SDS with each initial shipment and with the first shipment after an SDS is updated.

An SDS must include:

a. The specific chemical identity and common names of the hazardous chemical(s) involved;

b. Physical and chemical characteristics of the hazardous chemical;

c. Known acute and chronic health effects and related health information; exposure limits; whether the chemical is considered a carcinogen by the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC) or OSHA;

d. Precautionary measures;

e. Emergency and first-aid procedures, and the identification (including name, address and telephone number) of the organization responsible for preparing the SDS.

When UTSA faculty and staff purchase chemicals, the SDS is usually sent to LSD where a master SDS file is maintained. If an SDS is received with a chemical shipment, please forward a copy to LSD. Employees may request copies by contacting the LSD; be sure to include the full chemical name as it appears on the label and the manufacturer.

SDS's must be available within the workplace. Laboratories can keep paper copies of SDS's for all chemicals used or can have SDS database links on at least one computer in the laboratory. Database links are available from EHSRM's website http://utsa.edu/safety/. A shortcut to the SDS database must be maintained on the computer's desktop.

3. **Training**. All laboratory personnel who use or handle hazardous chemicals must receive training on the hazards of those chemicals and measures they can take to protect themselves – available courses are listed in Section VI – Training Requirements. Training must include information on interpreting container labels and SDS's; the location, acute and chronic effects, and safe handling of hazardous chemicals to which personnel may be exposed; the proper use of protective equipment and first-aid treatment; and general safety instructions on the handling and clean-up procedures and disposal of hazardous chemicals. Training must be provided before the employee works with, or in a laboratory containing, any hazardous chemical. Retraining is required when the potential for exposure to hazardous chemicals in the laboratory increases significantly or when the principal investigator receives new and significant information concerning the hazards of a chemical.

   The principal investigator / laboratory supervisor is responsible for providing continued training as necessary. All training must be documented, including the date, employee names and signatures, and the subjects covered in the session. Once laboratory specific training is completed, principle investigators must forward a copy of the training record to LSD.

2. Responsibilities under the act

Refer to this plan's Section III.

3. References

Further information regarding the Texas Health & Safety Code Title 6, Chapter 502 – Hazard Communication Act can be found at https://statutes.capitol.texas.gov/Docs/HS/htm/HS.502.htm. A copy of the Notice to Employees from the Texas Department of State Health Services is located at https://dshs.texas.gov/hazcom/publications.aspx in both English and Spanish and on the Laboratory Safety Division website.

B. INSTITUTIONAL SAFETY AND COMPLIANCE COMMITTEES

The following faculty led committees were established to be an institutional oversight of safety and compliance functions of all research activities conducted at UTSA. The committees provide review and guidance to assist researchers in fulfilling federal, state and institutional requirements for safe and compliant research. In addition the committees facilitate communication between faculty and institutional divisions responsible for safety and regulatory oversight.

1. Chemical Safety Committee (CSC)

The CSC is charged with promoting safe research with hazardous chemicals in research and teaching laboratories across campus. The committee reviews risk assesments for working with high hazard chemicals, reviews and contributes to the Chemical Hygiene Plan, advises in incident investigations. The committee is also empowered to recommend additional general safety rules with regard to chemical use and establish standard procedures for handling and working with chemicals.

2. Institutional Animal Care and Use Committee (IACUC)

The IACUC is a research review committee federally mandated by the Animal Welfare Act and the PHS Policy on the Humane Care and Use of Laboratory Animals. Through the expertise of the committee members, which comprise faculty, compliance professionals, safety professionals and community members the IACUC is charged with ensuring that all animal welfare issues associated with research across UTSA. The IACUC may also, in consultation with the CSC, set standards for the use of certain hazardous chemicals and pharmaceuticals in animal research to protect both animals and animal handlers.

3. Institutional Biosafety Committee (IBC)

The IBC is mandated to be a review body for oversight of all research activities involving the use of hazardous biological materials and recombinant or synthetic nucleic acids, as required by the NIH Guidelines for Research Involving Recombinant or Synthetic Nucleic Acid Molecules and the CDC/NIH Biosafety in Microbiological and Biomedical Laboratories (BMBL).

4. Radiation and Laser Safety Committee (RLSC)

The RLSC reviews all work with radioactive materials, X-Ray devices and lasers in research, engineering and teaching at UTSA. The committee is charged with implementing safety policies, procedures and practices with all systems and provides guidance to the Radiation and Laser Safety Officers in all areas of radiation and laser safety.

5. Institutional Review Board (IRB)

The UTSA Institutional Review Board (IRB) is the university committee that reviews and approves human subject research for the purpose of protecting the rights and welfare of those subjects. The Board is charged with the responsibility to formulate and implement procedures to assure UTSA's compliance with federal, state and institutional regulations for the safeguarding of the welfare and well-being (physical, mental, social, legal, etc.) of human subjects involved in research projects in which UTSA is engaged or for which UTSA otherwise exercises oversight.

The UTSA IRB operates under a Federal wide Assurance (FWA) with the Office for Human Research Protections (OHRP) under the Department of Health and Human Services. The IRB advises and educates researchers, staff and students on research with human subjects and promotes best practices for the ethical conduct of research with these individuals.

6. Laboratory Safety Advisory Committee (LSAC)

The Laboratory Safety Advisory Committee (LSAC) is a faculty and administration led committee that serves in an advisory capacity to the Vice President for Research, Provost and Vice President for Academic Affairs, and Vice President for Business Affairs and on issues, policies, and procedures related to laboratory safety. The LSAC ensures a strong safety culture at UTSA by providing an open and transparent communication mechanism between various stakeholders across the university campuses.

III. RIGHTS AND RESPONSIBILITIES

All faculty staff and students have the right to be informed about the potential hazards of the chemicals in their work area and receive adequate training to handle, and work with the items, safely. The culture of safety at UTSA is a shared responsibility and as such all personnel have a duty to fulfill their obligations with respect to maintaining a safe work place. All personnel working with potentially hazardous chemicals must participate in assigned training, be familiar with the CHP, stay informed with regard to the specific hazards in their laboratory space and wear the specified Personal Protective Equipment.

A. VPREDKE, DEANS AND DEPARTMENT CHAIRS

Commitment to a culture of safety and responsible research extends to all levels of UTSA's administration.

1. The Vice President for Research, Economic Development and Knowledge Enterprise (VPREDKE) is responsible for appointing faculty members to the Chemical Safety Committee who will advise upper administration of safety related policies and incidents, where necessary.
2. Deans and Department Chairs are responsible for ensuring that all work performed within their departments complies with UTSA safety plans and policies within their areas. Deans and Department Chairs should work with members of the Laboratory Safety Division and faculty to maintain programs that promote a safe working environment.
3. In the event of safety incidents within departments, Deans and Department Chairs will provide communication and support to faculty and laboratory safety staff to facilitate the prompt resolution of any issues.

B. LABORATORY SAFETY DIVISION

The Laboratory Safety Division is responsible for the development and implementation of Laboratory Safety Program and CHP. The Chemical Hygiene Officer (CHO) has primary responsibility for implementation of the components of the CHP. In the case of immediate danger to life or health the Interim Laboratory Safety Manager and / or the Associate Vice President for Research Administration has the authority to order the immediate cessation of the activity until the hazard is mitigated. The Laboratory Safety Division is responsible for:

1. Supporting students, staff and faculty in the development of a safe and productive research environment.
2. Establishing general procedures, policies and minimum standards for the use of chemicals and hazards that may be present at UTSA.
3. Developing and maintaining safety plans and training programs relevant to the safe use, storage and disposal of chemicals agents. These plans should be reviewed on an annual basis and updated as needed.
4. Performing hazard assessments..
5. Reviewing risk assessments for work with chemical agents in conjunction with the Chemical Safety Committee, and provide recommendations for the safe use, storage and disposal of chemicals per established procedures.
6. Assisting Departments and Principal Investigators in developing SOPs when requested.

7. Approving the purchase and use of hazardous chemicals and toxins that may require institutional approval.
8. Supervising decontamination and clean-up activities following chemical spills.
9. Investigating chemical spill and / or potential exposure incidents. Provide chemical monitoring to determine potential exposure levels where appropriate in conjunction with EHSRM.
10. Evaluating laboratories periodically, to ensure compliance with institutional, state and federal guidelines and regulations. Evaluations are conducted on a quarterly, semi-annual or annual schedule in each laboratory based on the laboratory's established hazard rating.

C. CHEMICAL SAFETY COMMITTEE

1. Supporting all UTSA faculty and staff in the promotion of safe research practices.
2. Reviewing the use of hazardous chemicals in research at UTSA.
3. Review and advise the CHO when variances from standard campus safety practices, regarding hazardous chemicals, are requested.
4. Reviewing and prescribing special conditions, requirements and restrictions that may be necessary for the safe handling of hazardous chemicals, and nanoparticles for the protection of personnel and property, including, but not limited to:
    a. Requiring students, staff and researchers to take additional training.
    b. Requiring the use of additional or specialized personal protective equipment.
    c. Requiring environmental monitoring.
    d. Requiring facility upgrades (chemical fume hoods, safety equipment, storage space).
    e. Requiring posting of additional safety / caution signage.
    f. Requiring specific or specialized chemical waste disposal processes and procedures in the laboratory.
    g. Requiring specialized handling techniques.
    h. Requiring special procedures following incidents or accidents.
5. Reviewing reports of any incidents or accidents associated with hazardous chemicals, nanoparticles, or hazardous laboratory conditions. At the request of higher administration the CSC will review new or existing risk assesments following and incident or accident.
6. In response to incidents, the CSC may recommend remedial actions, including temporary suspension or termination of an approved research for working with hazardous chemicals, and nanoparticles. The CSC may recommend that an approved procedure meets the criteria for remedial action, suspension or termination and the Associate Vice President for Research Administration will notify the P.I. that a specific activityhas been suspended pending further action.
7. Provide support and guidance, when requested, during incidents involving chemicals not covered by CSC risk assesments.

8. Annually review the CHP and provide advice and guidance.

D. ENVIRONMENTAL HEALTH SAFETY AND RISK MANAGEMENT (EHSRM)

EHSRM will:

1. Have the Director serve as the Institutional / Campus Safety Officer as per HOP 9.6.
2. Maintain a chemical waste disposal program.
3. Supervise decontamination and clean-up activities following chemical spills.
4. Investigate chemical spill and / or potential exposure incidents. Provide chemical monitoring to determine potential exposure levels where appropriate.

E. PRINCIPAL INVESTIGATORS (P.I.), LABORATORY OR TECHNICAL SUPERVISORS

Principal Investigators (P.I.), Laboratory or Technical Supervisors will:

1. Enforce all UTSA standard operating procedures (SOP's) and policies regarding chemicals and other relevant equipment within their laboratory space or work area.
2. Develop lab specific safety procedures or protocols for the safe use, storage and disposal of chemicals in their laboratory.
3. Determine whom within their laboratory needs chemical hygiene and hazard communication training, and ensure laboratory personnel to include staff, students, volunteers and visiting researchers have been properly trained to work safely within their laboratory or work area.
4. Keep a **written** record of pertinent training classes, lectures, hands-on training, hazard communication training with dates, times and appropriate signatures on file.
5. Ensure that new staff attends mandatory Hazard Communication and Laboratory Safety Training and/or Hazardous Waste Generator's Courses as appropriate to their work and offered by EHSRM and the Lab Safety Division prior to direct contact with hazardous chemicals or toxins. For questions on mandatory and relevant training courses please contact Laboratory Safety Division personnel.
6. Advise the Lab Safety Division of any significant protocol changes and prior to bringing new hazardous chemical(s) onto campus. Some chemicals, biologicals and equipment require approval prior to ordering. See Appendix I Hazardous Materials Requiring Institutional Approval.
7. Immediately report any exposures, spills, thefts or other incidents, resulting in injury to personnel or damage to property or equipment, involving chemicals to the Laboratory Safety Division for investigation or assistance.
8. Notify the Laboratory Safety Division and any relevant committee (CSC, LSC, etc.) of any significant protocol changes and prior to bringing new hazardous materials, chemicals and/or equipment) onto UTSA property. Provide the Laboratory Safety Division with an updated and verified chemical inventory of each laboratory or work area with chemicals at least annually. CAS numbers and unabbreviated chemical name must be used for identification. Additionally, the maximum quantity of each chemical on hand, at the time of submission, must be provided.

9. Report any plans to remodel or alter UTSA facilities (Refer to HOP 8.3 - Remodeling and/or Alterations to University Facilities) to Facilities, EHSRM, and LSD to obtain permission before proceeding.

F. LABORATORY PERSONNEL

This group includes all persons present in a laboratory space excluding EHSRM/LSD personnel and Principal Investigators. Laboratory staff includes, but is not limited to, undergraduate/graduate students, UTSA employees, visiting scholars, and volunteers.

Laboratory Staff and workers will:

1. Observe all established guidelines, departmental SOP's and UTSA policies and procedures for chemical safety to include accessing and reviewing SDS's as appropriate to determine hazard characteristics and handling procedures.
2. Maintain a clean and sanitary workplace. Chemicals should not be stored on benchtops or other surfaces outside fume hoods or chemical safety cabinets. All areas (benchtops, sinks, fume hoods, etc.) must be kept free of clutter, excess glassware, and must be well organized to avoid accidents or spills.
3. Attend all necessary or required training – refer to Section VI – Training Requirements. Only use hazardous chemicals for which they have been properly trained to handle and use.
4. Properly dispose of all laboratory wastes in accordance with laboratory standard operating procedures and UTSA waste management policy.
5. Report all spills or incidents to their supervisor and EHSRM/LSD if necessary.
6. Report to the PI/ Laboratory Supervisor and the LSD any perceived unsafe practices or conditions in the laboratory. Reports to the LSD can be made anonymously on the safety committee website at http://research.utsa.edu/research-funding/safety-committees/

G. THE LABORATORY SAFETY AND ADVISORY COMMITTEE (LSAC)

The LSAC will:

1. Assist in reviewing new safety issues involving laboratories at UTSA facilities and compliance with established regulatory and institutional policy.
2. Review Facility and Maintenance safety issues involving laboratories and relevant adjacent spaces.
3. Review continuing safety issues involving laboratories and recommend corrective action.
4. Have as serving members the Director of EHSRM and the Laboratory Safety Manager. Additional members / attendees may be approved by the chairperson.
5. Provide an advice to, or mediate with, Deans, Department Chairs, faculty appropriate safety committees and laboratory safety personnel in the aftermath of serious laboratory incidents if necessary.
6. Meet at least once per quarter.

IV. TRAINING REQUIREMENTS

A. LABORATORY SPECIFIC TRAINING

A safe laboratory environment is dependent on all personnel having a good understanding of the risks posed by the chemicals present and the procedures used.

Laboratory Safety provides online general safety training (described below) and will also provide this training in-person to individuals or laboratory groups on request. However, it is the responsibility of each laboratory to develop training appropriate to their specific research needs and Standard Operating Procedures. Laboratory Safety is available to assist P.I.s with any tools or documentation they may need to develop this training and maintain safety training records. Laboratories are dynamic environments and research practices and procedures change constantly therefore laboratory specific training should be reviewed by the P.I. every 6 months to ensure no new training is needed. Confirmation by the P.I. that the review has been conducted is tracked through ISMS by completing the on-line Laboratory Specific Training Acknowledgement.

Listed below are general areas that should be considered when developing training:

1. An overview of the UTSA Chemical Hygiene & Hazard Communication Safety Plan, its location and availability.
2. Hazardous chemicals present in their work place operations and how to handle these safely.
3. Physical and health hazards of the hazardous chemicals in their work area to include the Occupational Safety and Health Administration (OSHA) permissible exposure limits (PEL) and the American Conference of Governmental Industrial Hygienists (ACGER) Threshold Limit Values (TLV).
4. Methods and observation techniques used to determine the presence or release of hazardous chemicals in their work area.
5. Specific procedures and equipment in the laboratory and the hazards associated with their operation.
6. How to lessen or prevent exposure using personal protective equipment.
7. Steps the University has taken to lessen or prevent exposure to these hazardous chemicals.
8. Symptoms associated with exposure to chemicals found in the area.
9. Emergency procedures to follow if they are exposed to hazardous chemicals.
10. How to obtain appropriate hazard information from an SDS.
11. Location of SDS file and hazardous chemical list for their work area.

Training must be documented with the subject matter covered, date(s) of training and signed by the attendees.

B. ONLINE, REQUIRED, SAFETY TRAINING

1. Hazard Communication and Laboratory Safety Training

Hazard Communication (HazCom) training is mandated by both the federal and state governments (Texas Health & Safety Code, Title 6, Chapter 502 – Hazard Communication Act, section 502.009). If you will be exposed to hazardous chemicals within your work area, you must complete the Hazard Communications and Laboratory Safety (SA443.01) training course. Hazardous chemicals are defined as chemicals which have a physical or health effect. An irritation is a health affect. This training must be completed before the employee works with, or in an area containing, any hazardous chemical.

2. Hazardous Waste Generator Training

Hazardous Waste Generator training (SA401) covers chemical and biological waste disposal procedures in accordance with federal, state and local regulations. Generators must understand the requirements for proper bulking, packaging, labeling and disposal of hazardous waste.

V. GENERAL LABORATORY SAFETY GUIDELINES

Preparation is a vital component of creating a safe environment. This can include providing training on the lab specific hazards, informing personnel where they can locate fire extinguishers appropriate for the hazards present in their environment, knowing the location of safety showers and eyewashes and knowing who to ask for help.

All laboratory personnel have a responsibility for their own safety and the safety of others in their work environment. Prior to starting any work in the laboratory, ensure personnel are familiar with the procedures, equipment and chemicals that will be used and are aware of the general laboratory safety guidelines as well as any other associated hazards. Personnel should be able to easily access SDS for all the chemicals they may be using, know where to locate the CHP and have a plan in place should an incident happen. The Lab Safety Division office serves as a point of contact in case of any arising issues, staff and faculty are encouraged to contact the office at any time. Each laboratory is unique in their research and therefore should create a safety plan specific to their facility using the CHP as a foundation. Templates and guidance for creating safety plans can be found on the Laboratory Safety Division website and by contacting the laboratory safety staff directly.

Below are general guidelines for working safely in any laboratory.

A. GUIDELINES

1. To ensure that help is available if needed, do not work alone if using hazardous materials or performing hazardous procedures.
2. To ensure that help is available in case of emergencies, laboratory personnel should not deviate from the assigned work schedule without prior authorization from the laboratory supervisor.
3. Do not perform unauthorized experiments.
4. Plan appropriate protective procedures and the positioning of all equipment before beginning any operation. Follow the appropriate standard operating procedures at all times in the laboratory.
5. Always read the SDS and the label before using a chemical in the laboratory.
6. Wear appropriate PPE, including a laboratory apron or coat, at all times in the laboratory. Everyone, including visitors, must wear appropriate eye protection in areas where laboratory chemicals are used or stored.
7. Wear appropriate gloves when handling hazardous material. Inspect all gloves for holes and defects before using.
8. Use appropriate ventilation such as laboratory chemical hoods when working with hazardous chemicals.
9. Contact the Chemical Hygiene Officer (CHO) if you have questions about the adequacy of the safety equipment available or chemical handling procedures. Report dangerous activities or situations to your laboratory supervisors and the CHO.
10. Know the location and proper use of the safety equipment (i.e., eyewash station, safety shower, fire extinguisher, first-aid kit, fire blanket, chemical spill kit, emergency telephone, and fire alarm pulls).

11. Always incorporate safety into your experiments and anticipate and account for things that could go wrong. Never compromise safety in the interest of time.
12. Remove gloves before handling items such as the telephone, doorknobs and computer keyboards.
13. Always remove gloves and wash hands thoroughly before leaving the laboratory.
14. Designate specific break areas outside the laboratory for eating and drinking. Remember, smoking is prohibited on all UTSA campus areas.
15. Store food and drinks in refrigerators designated for consumable items, away from areas containing chemical, biological or radiological hazards.
16. Be aware of dangling jewelry, loose clothing or long hair that might get caught in equipment. Secure or remove these items in order to work safely.
17. Do not wear shorts, skirts, sandals or open-toed shoes in the laboratory. Shoes that completely cover the foot and shed liquids provide the most protection and should be worn in the laboratory.
18. Always wear appropriate personal protective equipment.
19. Keep aisles and walkways clear, drawers, and cabinet doors closed while you’re working.
20. Do not store hazardous chemicals on the floor in high-traffic or open areas.
21. Never pipette by mouth.
22. Do not allow non-matriculating minors (anyone under 18 years of age) into the laboratory without prior approval as outlined in HOP 2.44.

VI. PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) is a device or clothing worn to help protect you from direct exposure to hazardous materials. Examples include safety glasses or goggles, laboratory coats or aprons, gloves, face shields and respirators. **Remember, PPE only protects you if you use it**. Consult SDS's or other references for information on the PPE required for working with a particular chemical.

A. EYE AND FACE PROTECTION

Appropriate eye and face protection should be selected after a careful risk assessment of all the hazards involved in conducting a specific procedure. Eye protection must meet standards for impact resistance and provide splash protection. Safety glasses with side shields usually provide adequate impact resistance with limited splash protection and, therefore, consideration must be given to the splash risk of the procedure being performed. Chemical splash goggles (with no direct perforations around the goggles) provide adequate impact resistance and splash protection and limited vapor protection and therefore provide the best all-around eye protection. Vapor resistant goggles are available if needed. The Laboratory Safety Division recommends that all personnel wear chemical splash goggles while working with hazardous chemicals and can provide guidance in selecting and sourcing eyewear.

In addition to protective eyewear, face shields or freestanding shields should be used in situations where implosion or explosion may occur. Follow these guidelines for effective eye and face protection.

1. Wear protective eyewear at all times in the laboratory.
2. Wear chemical splash goggles for maximum protection, especially if you wear corrective lenses (glasses or contacts).
3. Splash and vapor resistant proof googles are the only accepted eyewear in all teaching laboratories where chemicals can be found. Everyone in the lab must wear these at all times.

B. HAND PROTECTION

Gloves protect your skin from the chemicals you work with. Not all gloves, however, are effective in providing protection against chemicals. Disposable latex gloves protect against water, dirt and microorganisms, but they do not protect against many solvents and must not be used for handling chemicals. There are several varieties of gloves (i.e., butyl, Neoprene, fluorocarbon (Viton), nitrile), each of which protect against different chemicals. There are also insulated gloves appropriate for work with cryogenic materials or hot glassware. Follow these guidelines for effective hand protection.

1. Wear gloves that provide the greatest protection from the chemical(s) with which you are working. Information on chemical-resistant gloves is available from various manufacturers, online or from the Lab Safety Division.
2. Wash your hands promptly after removing protective gloves to avoid exposure due to microscopic holes, tears, solvent penetration or accidental contact with the outside of the gloves when removing them.
3. Remove gloves when handling laboratory common items (telephones, keyboards, doorknobs, etc.) to prevent their contamination.

4. Do not wear gloves or laboratory coats outside the laboratory.

GLOVE TYPE	RECOMMENDED USE GUIDELINES
NITRILE	General use
BUTYL RUBBER	Ketones and esters
NEOPRENE	Acids, bases, alcohols, fuels, peroxides, hydrocarbons (not halogenated or aromatic), phenols
NORFOIL	Most hazardous chemicals
VITON	Chlorinated and aromatic solvents
POLYVINYL CHLORIDE (PVC)	Acids, bases, oils, fats, peroxides and amines
POLYVINYL ALCOHOL (PVA)	Aromatic and chlorinated solvents

Table 1. Glove types and recommended usage.

C. BODY PROTECTION

The most common form of body protection in the laboratory is the laboratory coat. Laboratory coats protect your skin and clothes in the event of a spill or a splash. Chemical-resistant aprons provide extra frontal protection when there is a greater potential for spills or splashes, as when you are transferring chemicals from one container to another. Follow these guidelines for effective body protection.

1. Protective clothing should be easily removable and free from rips or tears.
2. Wear your laboratory coat or apron only in the laboratory to prevent the potential spread of contamination.
3. Always wash laboratory clothes separately from personal laundry.
4. The following are not to be worn in laboratories: high-heeled or open-toed shoes, sandals or woven shoes, shorts or miniskirts, or excessive, or dangling jewelry.

D. RESPIRATORY PROTECTION

Respiratory protection in the laboratory is normally provided by engineering controls such as the ventilation system and chemical fume hood(s). When a higher level of respiratory protection is required, a half- or full-face respirator can be used. Contact EHSRM/LSD for assistance in selecting the correct respirator and cartridges. Medical assessment, fit testing and training on proper use and storage are necessary prior to using a respirator. Follow these guidelines for effective respiratory protection:

1. To note chemical odors, use a wafting motion of the hand to dilute the fumes before they reach your nose. Never inhale chemical fumes directly.
2. Do not use a respirator unless you have been trained to do so and have undergone a medical evaluation as well as had the respirator fit-tested.
3. If you are wearing a respirator, be sure the appropriate cartridges are used.
4. Properly store a respirator to prevent continued contamination and exhaustion of the cartridges.

VII. ENGINEERING CONTROLS

A. CHEMICAL FUME HOOD

The laboratory chemical fume hood is a ventilated enclosure designed to capture, contain and exhaust fumes, gases, vapors, mists and particulate matter generated within the hood interior. The fume hood is one of the most common and important safety devices in a laboratory, so it is important to ensure that fume hoods are achieving maximum containment to provide maximum protection. Several factors decrease fume hood containment: excessive storage of equipment and chemicals inside the hood; high traffic, fans, air-conditioning vents and doors to hallways being propped open; blockage of baffle slots (exhaust openings in the back of the hood); and a high sash position (open hood face). These factors result in the generation of turbulence inside the hood, cross-drafts that disrupt hood air-flow patterns and decreased face velocity. The optimum flow rate on a fume hood is 100 feet per minute plus or minus 20 percent.

Follow these guidelines for proper hood use:

1. If large equipment must be used or stored inside the fume hood, place the equipment on blocks at least two inches off the work surface so the baffle slots are not blocked. This allows air to flow beneath the equipment.
2. Do not use the fume hood interior for a chemical storage cabinet. However, if some chemical storage inside the hood is necessary, place the containers on shelving against the side walls (not the back wall) of the hood so the baffle slots are minimally blocked.
3. Do not keep loose paper, towels or Kim wipes inside the hood. These materials can get caught in the exhaust fan and result in fume hood downtime.
4. Equipment and other materials should be kept at least six inches behind the sash (hood opening) during experiments. This will reduce the exposure of personnel to chemical fumes that may escape into the laboratory due to small cross-drafts.
5. When the hood is not in use, keep the sash all the way down. When the hood is in use, keep the sash as low as possible to protect yourself against explosions or chemical splashes.
6. The fume hood is not a substitute for personal protective equipment. Wear your safety goggles, gloves and laboratory coat while working in a fume hood.
7. Ensure the exhaust fan is on and operating before you use a fume hood.
8. Newer models of fume hoods have audible alarms that go off when the face velocity in the hood falls below a certain level. Discontinue all work if the alarm sounds and ensure that the problem has been corrected before you continue.
9. Examinations and maintenance of all laboratory fume hoods are performed by Facilities personnel. Ensure that the system is tested at least every six months and that a visual inspection sticker is placed on the system.
10. Place a visual indicator that shows air movement at the face of the hood. A strip of tissue paper works well. If the indicator is being pulled into the fume hood, the hood is functioning. If the indicator is hanging straight down stationary, the hood is not functioning. If the indicator is blowing out into the laboratory, the hood is

not functioning and any contaminants in the hood are flowing into the laboratory. If the hood is not functioning, contact Facilities Work Control immediately to have the hood repaired.

B. PERCHLORIC ACID HOOD

Perchloric acid is a highly reactive, chemical. Its use inside a fume hood results in the deposition of perchloric acid precipitates that are potentially explosive. All work involving perchloric acid in excess of 3mL of 70% solution must be performed in an appropriate perchloric acid fume hood equipped with a wash-down system in the duct work to avoid precipitate buildup. Since perchloric acid reacts violently with other chemicals—such as organic materials or dehydrating agent—the perchloric acid hood must be washed down after each use and dedicated only to work involving perchloric acid. These hoods should be marked “perchloric acid hood.” Contact the Laboratory Safety Manager for the location of the perchloric acid fume hoods on campus.

C. RADIOISOTOPE FUME HOOD

A radioisotope hood is designed to minimize the risk of exposure by making it easier to maintain the hood in an uncontaminated condition. This hood is constructed of stainless steel and sealed to eliminate hard-to-clean areas that would allow the accumulation of radioactive materials. In situations where relatively high levels of radioactive materials are used or where the levels of radioactive fumes generated are substantial, a two stage, in-line high-efficiency particulate air (HEPA) filter may be necessary. Hoods for radioisotope use should be marked with the radioactive material symbol and “radioisotope hood.”

D. BIOSAFETY CABINETS

Biological safety cabinets are typically designed to provide both worker and product protection from infectious organisms not hazardous chemicals. They are equipped with high efficiency particulate air (HEPA) filters and may or may not exhaust air out of the laboratory. Therefore, most classes and types of Biosafety cabinet are not suitable for use of hazardous chemicals and open flames . All units must be tested, and certified, annually to ANSI/NSF-49 standards by licensed workers. A Biosafety Cabinet must never be used as a substitute for a fume hood.

E. GLOVE BOXES

A glove box is a laboratory device that creates an environment sealed from the atmosphere. Glove boxes are commonly used in chemistry laboratories to protect workers from hazardous and toxic materials or to protect chemicals and materials that may produce adverse or violent reaction when brought in contact with atmospheric contaminates such as water vapor or air.

Glove boxes may be used under either positive or negative pressure. Glove boxes that utilize a positive pressure system are usually connected to pressurized cylinders containing an inert gas that will protect any chemicals or material from coming in contact with the atmosphere. Negative pressure glove boxes are used to protect workers and are used for hazardous materials such as toxic gases or biological pathogens. Not all reagents and solvents are acceptable for use in the glovebox, the "box atmosphere" is usually continuously deoxygenated over a copper catalyst. Certain volatile chemicals such as halogenated compounds and especially strongly coordinating species such as phosphines and thiols can be problematic because they may poison the oxygen-scrubbing catalyst; catalyst must be closed during handling of these compounds, and the glovebox atmosphere be thoroughly purged prior to reopening the catalyst.

1. Daily Inspections

When using glove boxes, perform daily inspections prior to use. As part of your daily checklist, the following items should be inspected:

1. Check the condition of the gloves. Look for holes, areas of discoloration representing a compromised integrity, and the connection to the exterior.
2. Inspect the condition of the window, paying special attention to the area where the window is connected to the rest of the box.
3. Perform a vacuum pump inspection and ensure that all lines are in good condition and that the oil (if applicable) has been changed recently.
4. Inspect vacuum pump exhaust oil-mist filter and ensure it is still within operating parameters.
5. If your box is equipped with a solvent scrubber and solvent delivery system, ensure that the scrubber cartridges are within operating parameters.
6. All pressure gauges and indicators are functioning and are within acceptable ranges.

2. Other Considerations:

1. Perform routine maintenance on the system.
2. Avoid abruptly extending gloves into the box, this can severely stress the system and cause an over pressurization.
3. Use nitrile gloves on the glove box gloves. This extends the life of the glove box gloves and helps to avoid cross contamination and makes cleanup easier
4. Train all individuals working in the box. Document this training in a laboratory specific training file.
5. Ensure proper backup measures are in place for a loss of power or loss of facility nitrogen (if applicable).

F. SCHLENK LINE (VACUUM GAS MANIFOLD)

Vacuum/inert gas manifold systems, or Schlenk lines are a common alternative to glove boxes when working with air or moisture sensitive materials in research laboratories. Hydrogenations, Grignard reactions, pyrophoric manipulations, air and/or moisture sensitive chemicals are easily handled using Schlenk Line techniques. The design is based on modular setups of specialized glassware and tubing to create an inert environment.

The main body of a Schlenk line apparatus consists of a dual manifold with several ports.

The gas manifold is connected to a source of purified inert gas and is vented by means of an oil or mercury bubbler. The vacuum manifold is connected to a vacuum pump; solvent vapors and gaseous reaction products are prevented from contaminating the vacuum pump by a liquid-nitrogen or dry-ice/acetone cold trap. The vacuum lines from the house vacuum system will not be sufficient to support the requirements of a Schlenk line and vacuum pump must always be used.

1. Safety Considerations

Schlenk lines pose a number of potential hazards and personnel must always be trained on safe handling and practices. The main risks associate with Schlenk Lines are explosion, implosion and of accidental condensing of gases (particularly liquid oxygen)

Schlenk Line Cold Trap Safety (Liquid Oxygen Condensation)

Extreme care should be taken if liquid nitrogen is used in the cold trap of the Schlenk Line setup. The use of liquid nitrogen in the cold trap can lead to liquid oxygen condensation due to oxygen's higher boiling point (-183°C) when compared to Nitrogen (-196°C). Liquid o xygen presents a significant explosion hazard especially in the presence of organic solvents and other organic materials including vacuum grease and Teflon tape.

A light blue color in the trap indicates the presence of liquid oxygen. Experience lab personnel should be informed immediately if this is observed. To avoid condensing liquid oxygen, never open the vacuum line to the air when the cold trap is in place.

Other condensed gases

Some gases, such as carbon monoxide and ethylene, are also easily condensed in a liquid nitrogen-based cold trap. Once the liquid nitrogen is removed, either by choice or through evaporation, the condensed liquid will convert back to a gas with an accompanying increase in pressure. Without suitable pressure release, this build up may create an explosion hazard. A suitable pressure release system, such as an oil or mercury bubbler must remain attached to the line and the trap should be vented as soon as the liquid nitrogen Dewar is removed.

Common Causes of Explosion and Implosions

The most common cause for an explosion in a Schlenk Line apparatus is the buildup of excessive pressure within the system. This may occur due to pressure build up as a result of the use of inert gases, the heating a closed system or out-of-control reactions. To ensure adequate pressure relief the system must be attached to a bubbler and the lines to reaction vessels must remain open.

Implosion hazards are mainly caused by cracked, unsuitable or otherwise damaged glass. Structurally defective or improper (non-laboratory) glassware must never be used in a Schlenk Line apparatus.

2. Safe Handling and Use

1. All transfers of pyrophoric materials must be conducted using a cannula under positive pressure.
2. Positive pressure must be maintained at all times when using Schlenk Line apparatus.
3. All reaction vessels should be voided of atmospheric gases and moisture via the vac/fill cycle. This process should be repeated a minimum of 3 times.
4. De-gas and dry all solvents before use with reactive chemicals or materials.
5. Never heat a closed system, always ensure adequate pressure release of the system.
6. Inspect all glass ware and tubing before use to ensure structural integrity.
7. Potentially reactive waste must be treated dropwise with isopropanol before submitting it to Hazardous Waste Management

G. VACUUM PUMPS AND SYSTEMS

Most chemical fume hoods and biosafety cabinets are equipped with a connection to the "house-vacuum" system. This system creates suction via a large vacuum pump in a mechanical room whose piping extends to laboratories throughout the building. These house vacuum pumps are maintained by campus maintenance staff, and it is important the systems not be contaminated with hazardous materials or organisms.

Laboratories that are not connected to a house vacuum system, or that need a stronger vacuum, commonly employ stand-alone vacuum pumps such as rotary vane pumps, turbo pumps, diffusion pumps, and/or cryogenic vacuum pumps. These vacuum pumps are maintained by the personnel in each laboratory, and can present serval hazards if not properly handled. It is of the utmost importance to be familiar with the pump-model specific requirements and limitations when using this equipment. If in doubt, the supplier should be contacted for additional information and clarification. Generally the hazards associated with stand-alone vacuum pumps can be classified into two separate categories; chemical sources and physical sources.

1. Chemical Hazards

Chemical reactions involving gases or vapors which under normal conditions pose little risk, but are subject to increased reaction rates or other unexpected reactions when exposed to low or high pressure systems. Unexpected chemical reactions can occur when chemicals come into contact with gases or materials that were not originally taken into account when planning the experiment.

Leaks within the system that allow atmospheric gases to enter or flammable and toxic gases to leave the system is the greatest source of unintended violent reactions.

Additionally, gases and vapors which do not normally come into contact with each other during the process cycle may be mixed in the pumping system and exhaust pipelines.

Whenever solvents are used to remove deposits from the vacuum system, it is important to ensure that the selected solvent is compatible with all chemicals and materials encountered during the experimental process.

a. Explosion Hazards

The source of explosion hazards generally falls into one of the following categories:

1. Oxidants are often pumped in vacuum systems. Oxidants such as oxygen (O2), ozone (O3), fluorine (F2), nitrogen trifluoride (NF3) and tungsten hexafluoride (WF6) react readily with a wide range of substances and materials and the reaction often produces heat and an increased gas volume. It is highly recommended to always use a PFPE (perfluoropolyether) lubricant in pumps which are used to pump oxygen in concentrations above 25% by volume in an inert gas. These lubricants will not oxidize or break down in an oil-sealed rotary vane or piston and greatly reduce the probability of a system failure or explosion.

2. Flammable materials such as hydrogen (H2), acetylene (C2H2) and propane (C3H8) may ignite or become explosive within certain concentration ranges in the presence of an ignition source. Explosion hazards can be reduced by reducing the concentration of flammable gases and vapors via the introduction of an inert gas into the system.

3. Pyrophoric materials and gases, such as silane (SiH4) and phosphine (PH3), are spontaneously ignitable in air at atmospheric pressure. Combustion may occur when these gases are unintentionally exposed to the atmosphere anywhere in the vacuum system due to a leak or exhaust failure. If pyrophoric materials and

oxidants are present within the same process the probability of explosion at both atmospheric and process pressures increases greatly. Additional safety measures such as blast shields and other explosion containments must be taken into when you pump pyrophoric materials.

4. Unstable materials such as sodium azide pose and additional risk of explosion. Sodium azide can produce hydrozoic acid which in vapor form can react with heavy metals to form unstable metal azides. These azides may explode spontaneously. Brass, copper, tin and zinc are commonly used materials for vacuum pumps and accessories and pipes. For any experimental process that uses, or produces, sodium azide it must be ensured the gas path is free of heavy metal components.

b. Toxic or Corrosive Materials

Health hazards resulting from exposure to toxic materials are generally chemical and material specific. Whenever conducting experiments with toxic materials the SDS should be consulted to eliminate potential exposure risks.

Corrosive substances degrade the material they are in contact via ion exchange process in the presence of a suitable liquid solvent (such as water). While this mechanism cannot occur with materials is in the vapor phase, unplanned phase changes or condensation may lead to corrosive deposits. Special consideration should be given to possible changes in temperature and pressure when planning the experiment avoid this hazard.

The formation of corrosive or toxic deposits may also result from cross contamination if equipment is used for more than one purpose or has not been suitably cleaned and purged. An inert gas purge of the entire system should be conducted to avoid condensation of such materials.

Note: To capture most hazardous volatile liquids, a cold trap with dry ice and either isopropanol or ethanol is sufficient (to -78 degrees C). A liquid nitrogen cooling bath may be used only with sealed or evacuated equipment. Extreme caution should be taken if the system is opened while the cooling bath is still in contact with the trap, oxygen may condense from the atmosphere and react vigorously with any organic material present.

2. Physical Hazards

a. Over Pressurization

Over pressurization of a component of the system can be a result of several causes. The most common cause of an over-pressurized exhaust is a blockage or restriction in the exhaust system. All high vacuum pumps are compressors, which are specifically designed to operate under high outlet-to-inlet compression ratios and exhaust to atmospheric pressure. Exhaust pressure in excess of 7 bar gauge (8 x 105 Pa) may result from a blocked exhaust system.

The most common cause of over-pressure in a pumps inlet pipelines is the introduction of compressed gases during the purge with the pump not operating. If components in the inlet pipeline are not suitable for the resulting pressures pipelines and valves may rupture and process gases will leak from the system. A back flow of gases from the system into a process vessel, not capable of withstanding the pressure, may also cause ruptures and leaks pressure regulators which are designed to provide a low pressure flow or pressure monitor devices may be employed to minimize this hazard.

3. General Safety Considerations for Vacuum Systems

1. Consider all possible chemical reactions within your system. Include possible reactions that could occur under faulty conditions or system failure.
2. Refer to Safety Data Sheets when you assess the potential hazards associated with the experimental process for example, auto-ignition temperature.
3. Use the correct type of lubricant in your pump when you pump oxidants and pyrophoric materials.
4. Do not use heavy metals in the gas path of your pumping system if your process produces or uses sodium azide.
5. Ensure that safe working pressures for all components in the system are taken into account.
6. Incorporate the correct type of pressure relief devices, suitably rated for your application.
7. Ensure that exhaust blockages cannot occur.
8. Use PFPE (perfluoropolyether) oil when you pump oxidants.
9. Use an inert gas to dilute flammable and pyrophoric gas to safe levels.
10. You must not allow the maximum pressure of the system to exceed the maximum pressure rating of any single part of the system.
11. Ensure that the system is suitably controlled and regulated.
12. Leak test systems and equipment before use.

H. REFRIGERATORS AND FREEZERS

Follow these guidelines for proper laboratory refrigerator use:

1. Flammable liquids must be stored in flammable or explosion-proof refrigerators.
2. Refrigerators must be labeled prominently to indicate whether they are suitable for storage of flammable liquids.
3. Never place food or beverages in a refrigerator where chemicals are stored.
4. Refrigerators containing chemicals must be labeled “No Food or Drink.”

Dry Ice must never be stored in a refrigerator, freezer or other tightly sealed container.

VIII. CHEMICAL HAZARD CLASSES

A. GLOBAL HARMONIZATION SYSTEM

The Globally Harmonized System (GHS) of hazard communication recognizes thirty-one classes of chemical hazards. These classes fall within three categories – physical hazards, health hazards and environmental hazards. Each hazard statement is designated a code, starting with the letter H and followed by three digits. Statements that correspond to related hazards are grouped together by code number:

- H-2xx: Physical Hazard
- H-3xx: Health Hazard
- H-4xx: Environmental Hazard

Additionally, Precautionary Statements or P-statements are used to communicate safe handling, storage, and disposal requirements.

- P-2xx: Precautionary statements in relation to prevention.
- P-3xx: Precautionary statements based on accidental exposure and spill response.
- P-4xx: Precautionary statements concerning storage and safe handling.
- P-5xx: Precautionary statements in relation to disposal.

Any single chemical or compound may exhibit more than one hazard. The hazard class(es) of a particular material will determine how it should be stored, handled and disposed of, and what special equipment, engineering controls and procedures are needed to use it safely. Each chemical container, whether supplied by a vendor or reallocated in the laboratory, must include a GHS label that clearly identify the hazards associated with that chemical or mixture.

Be aware that many chemicals exhibit multiple hazards, in which case, the more prevalent hazard must be considered.

B. GHS PICTOGRAMS AND SIGNAL WORDS

The nine GHS pictograms and corresponding signal word make up the GHS symbol vocabulary for defining specific types of chemical-related hazards. The use of each pictogram is determined by the predefined hazard classification of the chemical of concern. These pictograms may be accompanied by a signal word (*Warning* or *Danger*) are used on chemical labels appearing on chemical products and on their accompanying safety data sheet (SDS). An example of the GHS pictograms can be found in Figure 1.

Oxidizers

Flammables, Self Reactives, Pyrophorics, Self-Heating, Emits Flammable Gas, Organic Peroxides

Explosives, Self Reactives, Organic Peroxides

Acutely Toxic (severe)

Burns Skin, Damages Eyes, Corrosive to Metals

Gases Under Pressure

Carcinogen, Respiratory Sensitizer, Reproductive Toxicity, Target Organ Toxicity, Mutagenicity Aspiration Toxicity

Toxic to aquatic environment

Acutely toxic(harmful), Irritant to skin, eyes or respiratory tract, Skin sensitizer, Hazardous to the Ozone layer.

Figure 1. GHS Pictograms.

C. CHEMICAL HAZARD CLASSES

1. Explosive and Potentially Explosive Chemicals

Explosive substances are materials that decompose under conditions of mechanical shock, elevated temperature, or chemical action, and release large volumes of gases and heat. These substances pose an immediate potential hazard and procedures that use or produce them must be carefully reviewed. These materials must be stored in a separate flame-resistant storage cabinet or, in many cases, in a laboratory grade refrigerator or freezer that is designed for storing flammable and reactive chemicals.

Class includes:

- Unstable explosives

- Explosives: Divisions 1.1 – 1.6
- Self-Reactive Substances and Mixtures (types A and B)
- Organic Peroxides (types A and B)

2. Oxidizing Chemicals

Oxidizers (e.g., hydrogen peroxide [H_2O_2], potassium dichromate, sodium nitrate) are substances that cause or contribute to combustion of organic materials. They often do so by giving up oxygen atoms. Oxidizers should be stored in a cool, dry place and kept away from flammable and combustible materials, such as wood, paper, Styrofoam, plastics, flammable organic chemicals, and away from reducing agents, such as zinc, alkaline metals, and formic acid

Class includes:
- Oxidizing gases – category 1
- Oxidizing liquids – categories 1, 2, 3
- Oxidizing solids – categories 1, 2, 3

3. Flammable, Combustible and Self-reactive Chemicals

Flammable liquids include those chemicals that have a flashpoint of less than 100 °F. These materials must be stored in flammable storage cabinets if aggregate quantities of 50 gallons/room or more are stored in the lab and/or the size of any individual container is greater than 5 gallon (20 L). Flame-resistant laboratory coats and splash proof googles must be worn when working with large quantities of flammable materials and/or with procedures where a significant fire risk is present. Particular attention should be given to preventing static electricity and sparks when handling flammable liquids

Class includes:

- Flammable gases, category 1
- Flammable aerosols, categories 1, 2
- Flammable liquids, categories 1, 2, 3
- Flammable solids, categories 1, 2
- Self-reactive substances and mixtures, types B, C, D, E, F
- Pyrophoric liquids, category 1*
- Pyrophoric solids, category 1*
- Combustible solids, category 3

- Combustible liquids, category 3
- Self-heating substances and mixtures categories 1, 2
- Substances and mixtures, which in contact with water, emit flammable gases, categories 1, 2, 3
- Organic peroxides, types B, C, D, E, F

***PYROPHORIC CHEMICALS**

Pyrophoric chemicals are a special classification of flammable materials that have autoignition temperatures below 130 °F, and thus may spontaneously combust in contact with air. The use of pyrophoric chemicals requires laboratory-specific training in addition to a general protocol. This class of chemicals should be handled within a glove box whenever possible. Flame-resistant laboratory coats must always be worn when working with pyrophoric chemicals. Never use or nitrile gloves because they do not self-extinguish upon combustion. Chloroprene gloves, coupled with flame resistant glove liners, should be worn when handling highly pyrophoric chemicals outside of a glove box.

Note: Please refer to Special Storage Handling Requirements for additional Information on safe handling of pyrophoric chemicals.

4. Water-Reactive Chemicals

Water-reactive chemicals when in contact with aqueous solutions or atmospheric moisture can develop toxic and/or flammable gases that will produce enough heat to readily ignite. Water-reactive substances must be stored a cool, dry place away from any potential water sources. Water reactive chemicals should always be stored in tightly sealed container, to avoid accidental release. They must never be stored in close proximity to acidic materials that could act as a source of protons and cause the evolution of hazardous gases. Water-reactive materials are indicated under GHS by varying pictograms based on the product of their reaction with moisture or water. Common examples include the flame pictogram, skull-and-crossbones pictogram, and corrosion pictograms. Water reactive substances are indicated under the National Fire Protection Association’s Standard System for the Identification of the Hazards of Materials for Emergency Response (NFPA 704) by a strikethrough “~~W~~”.

BEST PRACTICE

It is recommended that whenever working with pyrophorics, peroxides, or water reactive chemicals a container of dry sand is kept close to the work area to immediately extinguish fires.

5. Corrosive, Irritant and Sensitizing Chemicals

As a health hazard, corrosive substances cause irreversible destruction of, living tissue by chemical action at the site of contact. Major classes of corrosive substances include:

- Strong acids – e.g., sulfuric, nitric, hydrochloric and hydrofluoric acids
- Strong 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 and bromine.

CORROSIVES

Materials that are corrosive to tissue should always be stored below eye level. The physical hazard presented by corrosive substances may degrade materials they make contact with, especially metals, and may be violently reactive with other substances. Always consult the SDS regarding the materials they may corrode, and their reactivity with other substances, as well as information on potential health effects. Chemicals in this hazard class should be stored in chemically compatible secondary containers and should be segregated from other classes of materials (e.g. store acids separately from bases or water-reactive materials).

IRRITANTS

Irritants are defined as chemicals that cause reversible inflammatory effects. A wide array of organic and inorganic compounds, including many chemicals that are in a powder or crystalline form, are considered irritants. Symptoms of exposure can include reddening, burning, discoloration or discomfort of the exposed skin and irritation to respiratory systems and eyes.

SENSITIZERS

A sensitizer (allergen) is a substance or chemical that can prompt an exposed individual to suffer an allergic reaction after continuous or prolonged exposure to the substance. Common examples of sensitizing chemicals include diazomethane, chromium, nickel, formaldehyde, isocyanates, arylhydrazines, benzylic and allylic halides, as well as several phenol derivatives. Sensitizer exposure may lead to all of the symptoms associated with allergic reactions or can exasperate an individual’s already existing allergies.

6. Compressed Gases

A compressed gas is defined as a material in a container with an absolute pressure greater than 276 kPa, or 40 psi at 21 °C or an absolute pressure greater than 717 kPa (104 psi) at 54 °C, or both. Compressed gases expose laboratory personnel to both chemical and physical hazards. Compressed gases can be toxic, flammable, pyrophoric, oxidizing, corrosive, inert, or some combination of these hazards. Flammable compressed gasses with flash points significantly lower than ambient temperature present the danger of fire or explosion. Additional hazards may be caused by the reactivity and toxicity of the gas. Asphyxiation can be caused by high concentrations of even inert gases such as nitrogen. If Oxygen levels remain too low to sustain life over an extended period of time death may occur. Lastly, the large amount of potential energy resulting from the compression of gasses makes a compressed gas cylinder a potential rocket or fragmentation bomb.

The following are general recommendations for the safe handling of compressed gasses.

Note: The use of compressed gas cylinders in any laboratory requires prior risk assesment approval by the Chemical Safety Committee.

1. Be familiar with the gas's or gas-mixture's properties, safety precautions and hazards. Consult Safety Data Sheets (SDSs) for safety information.
2. Check Equipment for proper setup and leaks. Always use appropriately designed pressure equipment and ensure all materials are compatible with the specific gas or mixture
3. Develop emergency plans and procedures in case of equipment failure or leak.
4. Note: NEVER attempt to fix a leaking cylinder containing a non-inert gas yourself.
5. Never tighten a leaking regulator with a wrench, this will increase the chances of catastrophic equipment failure.
6. Follow all federal, state, and local regulations pertaining to the storage and use of compressed gas cylinders. Detailed regulatory requirements can be found in the National Fire Protection Association code NFPA-55, Chapter 7 (Compressed Gas)
7. If doubt arises over the correct handling, use or storage of any compressed gasses, or you feel you are unfamiliar with the hazards associated with a particular gas contact EHSRM or Laboratory Safety at (x8515) for additional guidance.

Hazard Identification and Labeling Requirements

All gas cylinders must be clearly labeled with contents, hazard class, hazard class symbol. These labels are usually affix to the cylinder by the manufacturer and must be visible at all times.

Compressed gas cylinders potentially fall under two separate labeling systems since the primary holding container also serves as the transport vessel. The Globally Harmonized System of Classification and Labelling of Chemicals (GHS) and the UN Recommendations on the Transport of Dangerous Goods Model Regulations (TDG) are the two main universally adopted hazard communication models. Labels may be based solely on either system or contain elements of both. The pictograms and hazard symbols differ slightly, and a correspondence table can be found below.

Hazard Class	GHS	UN Model
Gas Under Pressure • Compressed Gas • Liquified Gas • Refrigerated, Liquified Gas • Dissolved Gas		 
Flammable Gas (1A &1B)		 
Pyrophoric Gas		
Chemically Unstable Gas (A &B)		

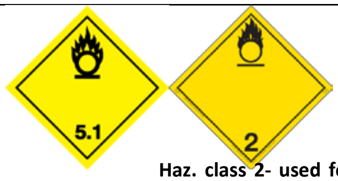
Oxidizing Gas		 **Haz. class 2- used for Oxygen only**
Corrosive Gas		
Acutely Toxic		
Severe Health Hazard • Carcinogen • Mutagen • Respiratory Sensitizer • Target Organ Toxicity		**None required**
Health Hazard **Irritant (skin/eye)** **Narcotic effect** **Respiratory Tract Irritant**		**None Required**
Hazardous to the Ozone Layer		**None Required**

Table 2. Gas Cylinder Labeling

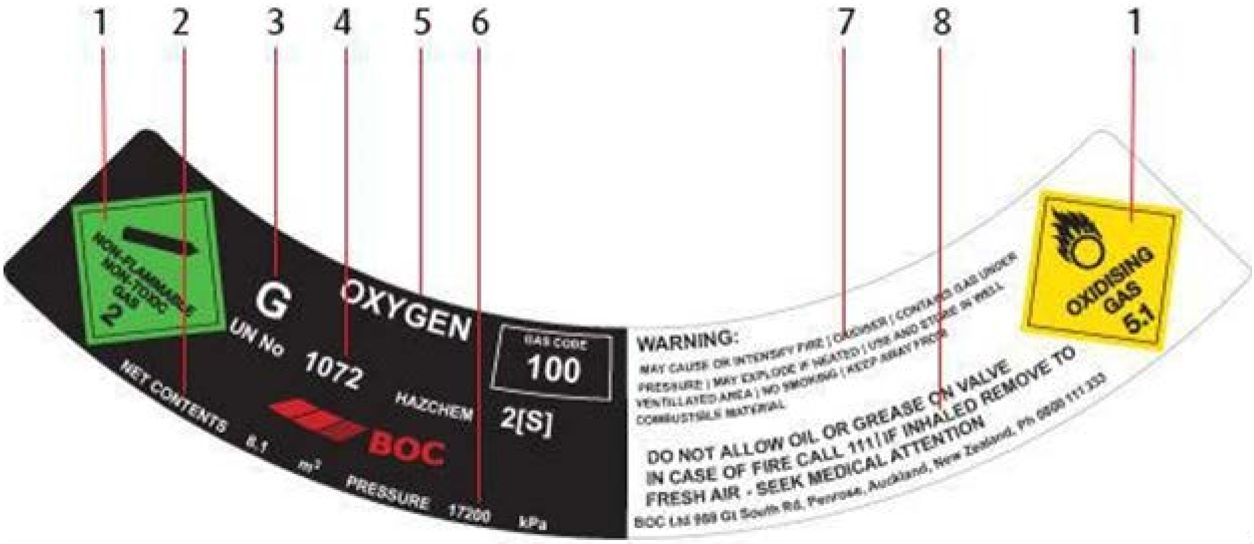


Figure 2. Example of a cylinder label. 1). Dangerous Goods Classification (Hazard Class), 2). Contents of cylinder at standard temperature and pressure (15°C @ 101.3 kPa), 3). Cylinder size, 4). United Nations (UN Model) numbering system for safe handling, transport and storage, 5). Gas name and grade, 6). Nominal filling pressure at standard conditions (for permanent gas), 7). Caution - indicated major hazards, 8). General safety information

Storage and Safe Handling

Several precautions should be taken during storage of compressed gas cylinders to minimize hazards

1. All cylinders must be stored in an upright position at all times and securely fastened to an appropriate wall bracket, floor stand or foot clamp.
2. Note: gas cylinders must never be clamped to a movable lab bench or to one another for support.
3. Full and empty cylinders should be stored separately and appropriately labeled with a tear-off tag as full, in use, or empty
4. Gas cylinders secured with a chain or strap must have the chain or strap attached 2/3 of the way up on the cylinder.
5. Cylinders should never be stored near heat sources or high voltage electrical equipment.
6. Gases should be used and stored only in a well-ventilated areas.
7. Gas Cylinders (in storage or empty) should have the gas cap in place. This is especially important for toxic, corrosive and highly flammable gases. Never store compressed gases for longer than one year without use.
8. Compressed gas cylinders should not be subjected to any mechanical shock that could cause damage to their valves or pressure relief devices. Cylinders should not be dropped, dragged, slid, or used as rollers for moving material or other equipment.

9. Never move a gas cylinder with a regulator or without the gas cap securely in place.
10. Oxidizers and flammable gases should have a minimum distance of 20 ft. from combustible materials and/or incompatible gases or substances.
11. Toxic/poisonous gases must be stored in a chemical fume hood or in a properly ventilated gas cabinet. Appropriate warning signs should be posted in the immediate area of the toxic or poisonous gas, outlining emergency procedures in case of exposure.
12. Inert gases are compatible with all other gases and may be stored together.

Further information on the correct segregation and storage amounts can be found in Appendix II.

Regulator selection

Regulators should be thoroughly inspected before attaching them to a gas cylinder. Regulators and pressure control devices must be selected based on the specific gas and must never be forced or otherwise altered to fit a connection. Tubing, piping and all fittings must be inert towards the specific gas. Information on appropriate regulators, tubing and fittings is available from the manufacturer or on the SDS.

Standard cylinder-valve outlet connections have been devised by the Compressed Gas Association (CGA) to prevent the mixing of incompatible gases due to an interchange of connections. Outlet threads used vary in diameter; some are male and some are female, some are right-handed and some are left-handed. In general, right-handed threads are used for nonfuel and water-pumped gases, and left-handed threads are used for fuel and oil-pumped gases. Information on the standard equipment assemblies for use with specific compressed gases is available from the supplier. To minimize undesirable connections that may result in a hazard, use only CGA standard combinations of valves and fittings in compressed gas installations.

7. Cryogens

A cryogenic liquid is defined as a liquid with a normal boiling point below –130°F (–90°C). Many of the safety precautions observed for compressed gases also apply to cryogenic liquids. Two additional hazards are created from the unique properties of cryogenic liquids:

1. **Extremely Low Temperatures** -The cold boil-off vapor of cryogenic liquids rapidly freezes human tissue, exposure can result in extensive tissue damage. Materials such as carbon steel, plastics and rubber become brittle and may fracture under stress.
2. **Vaporization** - All cryogenic liquids produce large volumes of gas (~ 1:1000) when they vaporize. Vaporization of cryogenic liquids in an enclosed area can cause asphyxiation and may result in death within minutes when oxygen levels are below 5%. Vaporization of liquid oxygen can produce an oxygen-rich atmosphere, which will support and accelerate the combustion of other materials. Vaporization of liquid hydrogen can form an extremely flammable mixture with air.

Common cryogens and their properties are summarized in Table 2.

Cryogen	**Boiling point (1 atm) °C (°F)**	**Critical pressure psig**	**Liquid density, g/L**	**Gas density (27°C), g/L**	**Expansion ratio (liq → gas)**	**Type of gas**

Argon	-186 (-303)	710	1402	1.63	860	Inert
Helium	-269 (-452)	34	125	0.16	780	Inert
Hydrogen	-253 (-423)	188	71	0.082	865	Flammable
Nitrogen	-196 (-321)	492	808	2.25	710	Inert
Oxygen	-183 (-297)	736	1410	1.4	875	Oxidizer

Table 2. Common Cryogens.

3. **Cryogenic Liquid PPE**

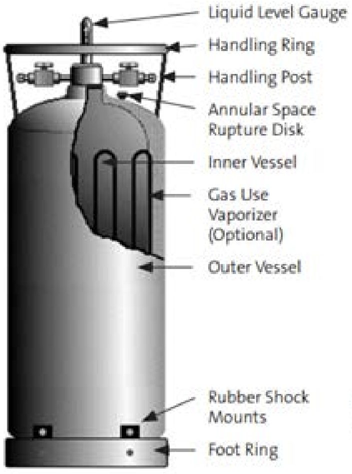
The following PPE is recommended when handling cryogenic liquids:

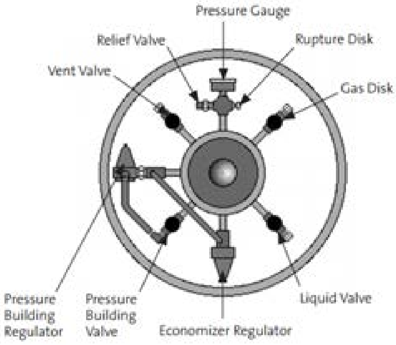
- safety glasses or goggles
- cryogenically rated, loose-fitting gloves
    - gloves should be loose fitting so that they can be quickly removed
    - cryogenic gloves are not rated for immersion into cryogenic liquids or for prolonged handling of cryogenically chilled materials
- long-sleeved shirt or lab coat, and pants without cuffs, closed shoes
- safety shoes are recommended for people involved in the handling of containers.

4. **Cryogenic Liquid Storage**

Cryogenic liquids can be transported, stored, and handled in a variety of containers depending on cryogen, quantity and intended use. Not all containers are engineered for all available cryogens. Special care must be taken to ensure the container is suited to safely store and dispense the specific cryogen. Improper use of storage containers can lead to catastrophic failure of the system. If a sufficient amount of liquid is vaporized within a closed container, resulting pressure could rupture the vessel. All cryogenic liquid storage containers are protected with multiple pressure relief devices. Cryogens must <u>never</u> be stored in unapproved or unsuitable containers.

Storage Containers





Dewars are non-pressurized, double walled containers used to contain cryogenic liquids. The area between the walls is kept under high vacuum for maximum thermal insulation. Dewars are usually equipped with a loose fitting, insulated cap that will allow small amounts of gases to escape while preventing moisture buildup at the neck. The Cryogen may be withdrawn as a liquid or a gas depending on engineered flow rate and pressure. A vacuum-jacketed (VJ) transfer line should be used to remove cryogenic gas in a liquid state. In many cases these dewars are used as "satellite" containers for liquid nitrogen within a laboratory, and are periodically refilled from a central storage tank.

Dewar flasks are smaller, double-walled cryogenic storage containers that usually only maintain the liquid for a few hours. They usually have a metal outer wall and a glass inner wall, with the void space under high vacuum. Special care should be taken when handling as these flasks can implode. Always inspect the walls for cracks and other weak points. Do not use a Dewar that has been dropped or subjected to other types of shock- not all stress points are visible to the naked eye.

Cryogenic Storage Tanks are filled by vendors on a set schedule and are used to refill dewars and cryogenic flasks on site.

Cryogenic tubes are typically used for storage, movement or shipment of samples. There is no pressure-relief device on a cryogenic tube other than the lid. Consequently, cryogenic tubes may explode without warning. Explosions are likely caused by trapped nitrogen expanding inside of the tube during the thawing process, this may result in serious injuries. Because of this risk, all recommended PPE should be worn when directly handling a sealed cryogenic tube.

8. Handling Cryogenic Liquids

Most cryogenic liquids are odorless, colorless, and tasteless when vaporized. When cryogenic liquids are exposed to the atmosphere, the cold boil-off gases condense the moisture in the air, creating a highly visible fog.

- Always wear proper PPE.
- Label all containers with content and appropriate warning signs.
- Always use proper containers designed for the transport and use of cryogenic liquids.
- Never tamper with or attempt to repair pressure valves, gauges and pressure relief devices.
- Examine containers and pressure relief valves for signs of defect. Never use a container with observable defects, or one which has not been designed to hold cryogenic liquids.
- Relief devices must not be removed or modified.
- Always handle these liquids carefully to avoid skin burns and frostbite. Exposure that may be too brief to affect the skin of the face or hands may damage delicate tissues, such as the eyes.
- Never touch uninsulated pipes or vessels containing cryogenic liquids. Flesh will stick to extremely cold materials, if this happens do not pull away instead use warm water to release. Even nonmetallic materials are dangerous to touch at low temperatures.
- Use wooden or rubber tongs to remove small items from cryogenic liquid baths. Cryogenic gloves are for indirect or splash protection only, they are not designed to protect against immersion into cryogenic liquids.
- Containers should be handled and stored in an upright position. Do not drop, tip, or roll containers on their sides.

- Do not remove or interchange connections. Contact the vendor if you experience any difficulty operating the container valve or with the container connections. Discontinue use. Use the proper connection. DO NOT USE ADAPTERS!

9. Special Consideration Based on Each Cryogen:

Argon and Helium: Liquid helium and liquid argon are both inert, colorless, odorless, non-corrosive, extremely cold, and nonflammable. They will not react with other elements or compounds under ordinary conditions and possess no warning properties that will allow humans to detect their presence. Although these gases are nontoxic and inert, they can act as a simple asphyxiant by displacing the oxygen in air to levels below that required to support life. Inhalation of helium or argon in excessive amounts can cause dizziness, nausea, vomiting, loss of consciousness and death. Death may result from errors in judgment, confusion, or loss of consciousness that prevents self-rescue. At low oxygen concentrations, unconsciousness and death may occur within minutes and without warning. Personnel, including rescue workers, should not enter areas where the oxygen concentration is below 19.5%, unless provided with a self-contained breathing apparatus or air-line respirator.

Hydrogen: Hydrogen is colorless as a liquid. Its vapors are colorless, odorless, tasteless, and highly flammable. Liquid hydrogen is non-corrosive. Hydrogen gas may produce suffocation by diluting the concentration of oxygen in air below levels necessary to support life. The amount of hydrogen gas necessary to produce an oxygen-deficient atmosphere is well within the flammable range, making fire and explosion the primary hazards. Hydrogen has a broad flammability range (4% to 74% in air), and only requires a small amount energy to ignite and will burn with a pale blue, almost invisible flame. Extreme care should be taken to avoid accidental release and to eliminate all sources of ignition, such as sparks from electrical equipment, static electricity sparks, open flames or any extremely hot objects. Gaseous and liquid hydrogen systems must be purged of air, oxygen, or other oxidizers prior to admitting hydrogen to the systems, and purged of hydrogen before opening the system to the atmosphere.

Nitrogen: Liquid nitrogen is inert, colorless, odorless, non-corrosive, nonflammable, and extremely cold. Nitrogen makes up the major portion of the atmosphere (78.03% by volume, 75.5% by weight). Nitrogen is inert and will not support combustion; however, it is not life supporting. Nitrogen when heated to very high temperatures will react with metals, such as lithium and magnesium to form nitrides, and when combined with hydrogen in the presence of catalysts, will form ammonia. Nitrogen acts as a simple asphyxiant by displacing the oxygen in air, and may cause dizziness, nausea, vomiting, loss of consciousness, and death.

Oxygen: Oxygen is the second largest component of the atmosphere, comprising 20.8% by volume. Liquid oxygen is pale blue in color and will react with nearly all organic materials. Although oxygen itself is nonflammable, it is a strong oxidizer. Any material or substance capable of burning in air will burn more vigorously in oxygen. Equipment used in oxygen service must meet stringent cleaning to eliminate any incompatible contaminants. Vessels containing oxygen must be stored away from flammable and combustible materials by a minimum of 20 feet or a half-hour fire wall. “No Open Flames” signs should be posted in the immediate storage area.

When pure oxygen is inhaled at pressures greater than 2 or 3 atmospheres, characteristic neurological syndromes can be observed which include nausea, dizziness, vomiting, tiredness, light-headedness, mood changes, euphoria, confusion, incoordination, muscular twitching and epileptic-like convulsions, and loss of consciousness. These effects are reversible after reduction of oxygen pressure.

D. PARTICULARLY HAZARDOUS SUBSTANCES

Hazardous chemicals belonging to certain classes are considered "Particularly Hazardous Substances" (PHSs). Special safety precautions must be established and communicated to prevent the harmful exposure of laboratory personnel to PHSs. In addition to several engineering controls it is advisable to establish clearly labeled designated areas of use and storage, the use of containment devices, waste disposal, and decontamination procedures. Particularly hazardous substances are divided into three primary types:

1. Carcinogens
2. Reproductive Toxicants
3. Acute Toxicants

1. Carcinogens

Carcinogens are chemical or physical agents that may cause cancer. Most carcinogensare considered chronically toxic substances that will cause damage after repeated or long-period exposure. Chronic toxins are particularly insidious because they may have no immediately apparent harmful effects, and harmful effect may only become apparent long after discontinuation of exposure.

Carcinogens are separated into three different classes:

1. Select Carcinogens
2. Regulated Carcinogens
3. Listed Carcinogens

Select Carcinogens
Materials which have met certain criteria established by the National Toxicology Program or the International Agency for Research on Cancer regarding the risk of cancer via certain exposure routes. It is important to recognize that some substances involved in research laboratories are new compounds and have not been subjected to testing for carcinogenicity.

Regulated Carcinogens
The materials fall into a higher hazard class and have extensive additional requirements associated with their use. The use of these agents may require personal exposure sampling based on usage and Institutional approval via the Chemical Safety Committee (CSC). Spills and exposures must be immediately reported to the Laboratory Safety Division.

Listed Carcinogens
Listed Carcinogens is a term referring to a list of thirteen specific chemicals contained in that are considered to pose the highest cancer hazard. They have further requirements for their use in addition to those of regulated carcinogens. Given these strict regulations for Listed Carcinogen use, handling, and/or storage, the Chemical

Hygiene Officer (CHO) must be contacted before any work with these agents begins. OSHA regulation 1910.1200(d)(5)(ii) requires that a mixture, "shall be assumed to present a carcinogenic hazard if it contains a component in concentrations of 0.1 percent or greater, which is considered to be a carcinogenic under this regulation".

2. Reproductive Toxicants

Reproductive toxicants include any chemical that may affect the reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis). Reproductive toxicants can affect the reproductive health of both men and women if proper procedures and controls are not used. These materials may also cause harm to breast-fed children.

Mutagens are materials that can cause a change (or mutation) in the genetic material of a living cell. Such mutations can lead to reproductive toxicity and may play a significant role in the development of cancer.

3. Acute Toxicants

Acute toxicants are substances that may be fatal as the result of a single exposure or exposures of short duration via one or more of three routes, which is defined as any of the following:

- A chemical with a median lethal dose (LD50) of 50 mg or less (oral) per kg of body weight.
- A chemical with a median lethal dose (LD50) of 200 mg or less (dermal) per kg of body;
- A chemical that has a median lethal concentration (LC50) in air of 500 ppm by volume or less of gas, 2.0 mg per liter or less of vapor, or 0.5 mg per liter or less of mist or dust, when administered by continuous inhalation for 4 hours (or less if death occurs within 4 hours).

Class includes:

- Category 1 acute toxic chemicals
- Category 2 acute toxic chemicals

4. Toxic Substances

Substances which may cause toxicity as the result of a single exposure, but are typically not fatal in small doses, are considered toxic.

Class includes:

- Category 3 acute toxic chemicals
- Category 4 acute toxic chemicals

Substances that cause damage to target organs are also considered to be toxic and include:

- **Hepatotoxins** – substances that damage the liver (e.g. nitrosamines, carbon tetrachloride)
- **Nephrotoxins** – substances that damage the kidneys (e.g. certain halogenated hydrocarbons)
- **Neurotoxins** – substances that damage the nervous system (e.g. mercury, acrylamide, carbon disulfide)
- **Hematopoietic agents** – substances that decrease hemoglobin function and deprive the body tissues of oxygen (e.g. carbon monoxide, cyanides)
- **Respiratory Toxicants** – Substances that damage lung tissue (e.g. asbestos, silica)

5. Chemicals Hazardous to the Environment

Materials with demonstrated toxicity to aquatic organisms are classified as toxic to the environment. The unique geographical location of UTSA above the Edwards Aquifer Recharge Zone warrants additional storage precautions for this class of chemicals. The greatest care should be taken to avoid any of these substances to be allowed to enter the drain and subsequently the ground water. As is the case for all other chemicals items displaying this label must be stored in a secondary, unbreakable container, able to contain 150% of the volume., and that they be disposed as hazardous waste.

6. Peroxide Forming Chemicals

Chemicals that may form potentially explosive organic peroxides (PFC) have not received an independent classification under GHS but are rather categorized under flammable liquids or solids. However, these chemicals pose a significant concern in research laboratories. Many of these chemicals are common solvents and care should be taken for solutions containing them. A common practice is the addition of stabilizers (e.g. hydroquinone and BHT) that inhibit the chain reaction of peroxide formation, whenever possible stabilized chemicals should be given priory during purchase from vendors. Peroxide forming chemicals should be stored in airtight containers in a dark, cool, and dry place. The containers should be labeled with the date received, the date opened and the test dates. This information, along with the chemical identity should face forward to minimize container handling during inspection.

Note: Please refer to Appendix II *for additional Information on safe handling, storage and testing of peroxide forming chemicals.*

IX. CHEMICAL STORAGE, SEGREGATION AND HANDLING

Each laboratory should develop safe chemical storage and segregation procedures based on general, as well as specific hazards presented by the chemical inventory on hand. The specific Safety Data Sheet (SDS) should be always consulted when doubts arise concerning specific chemical properties, safe handling and associated hazards. All laboratory personnel should receive general lab specific training before handling hazardous chemicals. All storage and handling procedures must comply with Fire Code, building code regulations (National Fire Protection Association (NFPA) 1, 101, 30, 45, 55, and 400, as applied by the Texas State Fire Marshal's Office, and International Fire Code, as adopted by the city of San Antonio, for the purposes of tactical firefighting only). Additionally, special consideration must be given to secondary containment due to the unique location of UTSA above the Edwards Aquifer recharge zone.

A. GENERAL RECOMMENDATIONS FOR SAFE STORAGE OF CHEMICALS

Each chemical in the laboratory should have a designated location and should be returned to that location after each use. Acceptable chemical storage locations may include corrosive cabinets, flammable cabinets, laboratory shelving and or wooden cabinets, appropriate refrigerators or freezers. Freezers should be defrosted periodically so that chemicals do not become trapped in ice formations.

Fume hoods and/or biosafety cabinets, bench tops, cabinets under sinks, or the floor are not long-term storage locations for chemicals. Hazardous or corrosive liquids should never be stored above eye level. Chemicals that are highly toxic or extremely corrosive should be kept in a secondary unbreakable container. Chemicals must be stored at an appropriate temperature and humidity level, away from heat and electrical sources and should never be exposed to direct sunlight for long periods of time. Chemical containers that are not in use must be tightly capped to prevent nuisance smells and adverse reactions. Whenever possible chemicals should be kept in their original container. If a chemical is transferred to a secondary container, it must be labeled based on the Globally Harmonized System (GHS) label requirements. Expired or contaminated chemicals should be submitted to Hazardous Waste Handling. Unwanted or unused chemicals should be entered in the Chem Swap program at UTSA (for more details regarding the Chem Swap program please contact the CHO at x8515).

Hazard Class of Chemical	Recommended Storage Method	Incompatibilities
Compressed Gas cylinders 	Store in a cool, dry area. Securely strap or chain cylinders to a wall or secure within cylinder floor stand. Lab benches must be rendered immobile before clamping cylinder to it.	Refer to Section VIII C 6 more detail on storage and handling requirements.
Corrosives – Acids 	Store separately in acid storage cabinet. Segregate oxidizing acids (i.e., Chromic, nitric*, sulfuric, and perchloric acids) from organic acids.	Flammable liquids, flammable solids, bases, oxidizers
Corrosives – Bases 	Store in separate corrosive storage cabinet. Store solutions of inorganic hydroxides in labeled polyethylene containers.	Flammable liquids, oxidizers, poisons, and acids

Flammable Liquids 	Store in flammable storage cabinet and away from sources of ignition. Store highly volatile flammable liquids in a fire or explosion proof refrigerator.	Acids, bases, oxidizers, toxins and poisons
Flammable Solids 	Store in a separate dry, cool area away from oxidizers, corrosives, flammable liquids	Acids, bases, oxidizers, toxins and poisons
General Chemicals - Non-reactive 	Store on general laboratory shelving preferably behind glass doors and below eye level if space permits.	See specific SDS.
Oxidizers 	Store in a spill tray inside a chemical storage cabinet. Separate from flammable and combustible materials.	Separate from reducing agents, flammables, and combustibles.
Poisons/Toxic Compounds 	Store separately in vented, cool, dry area, in unbreakable chemically-resistant secondary containers and in accordance with the hazardous nature of the chemical.	Flammable liquids, acids, bases, and oxidizers. See specific SDS.
Carcinogens 	Label all containers as "Cancer Suspect Agents". Store according to the hazardous nature of the chemical, using appropriate security when necessary.	See specific SDS.
Peroxide-Forming Chemicals 	Store in air-tight containers in a dark, cool, dry area.	See specific SDS.
Strong Reducing Agents 	Store in cool, dry, well-ventilated location. Water reactive. Segregate from **all** other chemicals.	See specific SDS.

Table 3. General chemical storage guidance.

B. CHEMICAL SEGREGATION

In addition to chemical storage requirements based on hazard class certain chemicals and classes of chemicals should never be stored together. Table 4 provides a list of commonly used chemicals in research laboratories and their respective incompatible chemical. Chemical hazardous waste containing these chemicals should also be segregated to avoid adverse and potentially hazardous reactions. Chemicals in column A should not be stored, packaged or handled in the same area as chemicals in Column B. Refer to the SDS for specific hazards upon contact.

CHEMICAL (COLUMN A)	KEEP OUT OF CONTACT WITH (COLUMN B):

Acetic acid	Chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetic anhydride	Hydroxyl-containing compounds such as ethylene glycol, perchloric acid
Acetone	Concentrated nitric and sulfuric acid mixtures, hydrogen peroxide
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali and alkaline earth metals such as powdered magnesium, sodium, potassium	Water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
Ammonia (anhydrous)	Mercury, halogens, calcium hypochlorite, hydrofluoric acid
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Arsenical materials	Any reducing agent
Azides	Acids, heavy metals and their salts, oxidizing agents
Calcium oxide	Water
Carbon, activated	All oxidizing agents, calcium hypochlorite
Carbon tetrachloride	Sodium
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible material
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Chromic acid and chromium trioxide	Acetic acid, alcohol, camphor, glycerol, naphthalene, flammable liquids in general
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids (organic or inorganic)
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens, other oxidizing agents
Fluorine	All other chemicals
Hydrides	Water
Hydrocarbons (e.g., butane, propane, benzene)	Fluorine, chlorine, bromine, chromic acid, peroxides
Hydrocyanic acid	Nitric acid, alkalis
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, any flammable liquid (i.e., alcohols, acetone), combustible materials, aniline, nitromethane
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Hypochlorites	Acids, activated carbon
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Metal hydrides	Acids, water
Nitrates	Acids
Nitric acid (concentrated)	Acetic acid, acetone, alcohol, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
Nitrites	Acids
Nitroparaffins	Inorganic bases, amines

Oxalic acid	Mercury and silver and their salts
Oxygen	Oils, grease, hydrogen; flammable liquids, solids, or gases
Perchloric acid	Acetic anhydride, alcohol, bismuth, paper, wood, grease, oils
Permanganates	Concentrated sulfuric acid, glycerol, ethylene glycol, benzaldehyde
Peroxides, organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus, white	Air, oxygen, alkalis, reducing agents
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Sulfuric and other acids, ammonium salts, metal powders, sulfur, finely divided organics, combustibles
Potassium perchlorate (see also chlorates)	Sulfuric and other acids
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Silver and silver salts	Acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
Sodium	Carbon tetrachloride, carbon dioxide, other chlorinated hydrocarbons, water
Sodium nitrate	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids

Table 4. Incompatible chemicals (*Adapted from Prudent Practices in the Laboratory: Handling and Disposal of Chemicals, National Research Council, 1995, with additions from OHS*)

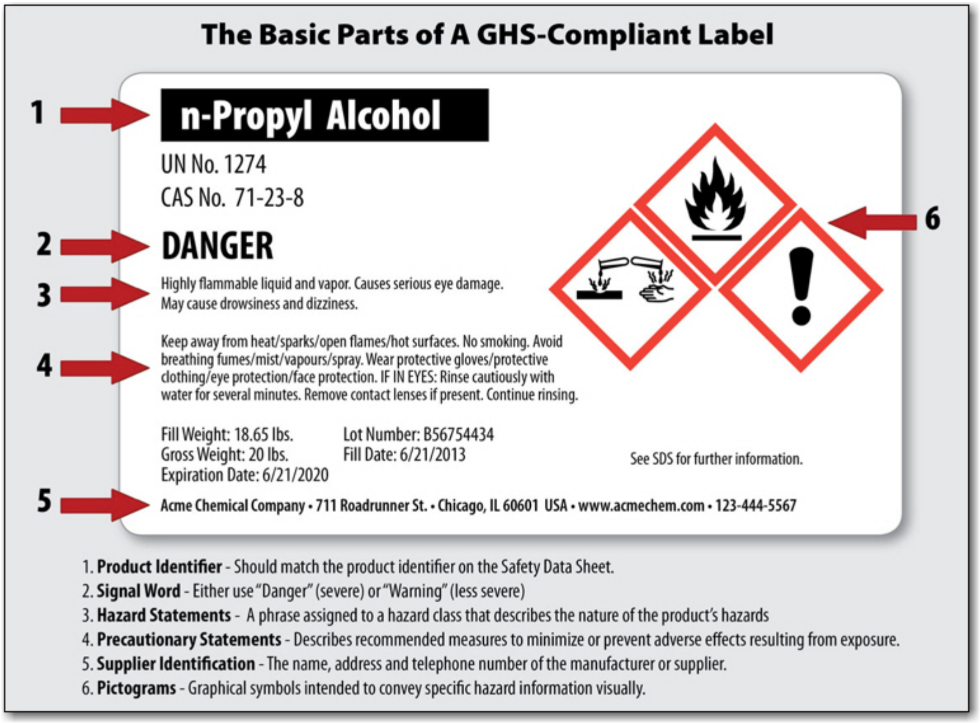
C. CHEMICAL LABELING REQUIREMENTS

With few exceptions, chemical containers and secondary media bottles used and stored in research laboratories at UTSA must be properly labeled based on GHS and OSHA standards to identify their contents, and their associated hazards. Proper chemical labeling and storage is essential for a safe laboratory work environment and is a requirement under the Texas Hazard Communication Plan. Inappropriate storage of incompatible or unknown chemicals can lead to spontaneous fire and explosions with the associated release of toxic gases. Proper labeling also facilitates quick decision-making and action in the event of an emergency (i.e., spillage, exposure, etc.), and avoids the expense associated with handling, management, testing and subsequent disposal of unknown chemicals. With a few exceptions, labels can be directly printed from the chemical inventory in ISMS by selecting the chemical name or CAS Number.

D. GENERAL GUIDELINES

Manufacturer chemical labels must never be removed or defaced until the chemical is completely used. If an original manufactures bottle is to be repurposed, the original label must be completely defaced or removed and a new label should be put in its place identifying the chemical or mixture within. Small containers and vials that are difficult to label may be numbered, lettered, or coded as long as an associated log is available that identifies the chemical constituents. Groups of small containers vials and Eppendorf tubes maybe labeled as a group and stored together. Original chemical containers should be labeled with the “date received” and “date opened”. All chemical and waste containers must be clearly labeled with the full chemical name(s) (no abbreviations or formulas), and must contain appropriate hazard warning information. Storage areas for hazardous materials like refrigerators, and cabinets should be labeled to identify the hazardous nature of the chemicals stored within the area (e.g., flammables, corrosives, oxidizers, water reactive, toxics and carcinogens).

E. GHS COMPLIANT LABELING



The Basic Parts of A GHS-Compliant Label

n-Propyl Alcohol

UN No. 1274
CAS No. 71-23-8

DANGER

Highly flammable liquid and vapor. Causes serious eye damage.
May cause drowsiness and dizziness.

Keep away from heat/sparks/open flames/hot surfaces. No smoking. Avoid breathing fumes/mist/vapours/spray. Wear protective gloves/protective clothing/eye protection/face protection. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present. Continue rinsing.

Fill Weight: 18.65 lbs.
Gross Weight: 20 lbs.
Expiration Date: 6/21/2020
Lot Number: B56754434
Fill Date: 6/21/2013

See SDS for further information.

Acme Chemical Company • 711 Roadrunner St. • Chicago, IL 60601 USA • www.acmechem.com • 123-444-5567

1. **Product Identifier** - Should match the product identifier on the Safety Data Sheet.
2. **Signal Word** - Either use "Danger" (severe) or "Warning" (less severe)
3. **Hazard Statements** - A phrase assigned to a hazard class that describes the nature of the product's hazards
4. **Precautionary Statements** - Describes recommended measures to minimize or prevent adverse effects resulting from exposure.
5. **Supplier Identification** - The name, address and telephone number of the manufacturer or supplier.
6. **Pictograms** - Graphical symbols intended to convey specific hazard information visually.

Figure 3. Elements of a GHS compliant label.

The standardized label elements included are:

1. Pictograms: Convey health, physical and environmental hazards information, assigned to a GHS hazard class and category. All applicable pictograms should appear on the label.

2. Signal Words: "Danger" or "Warning" will be used to emphasize hazards and indicate the relative level of severity of the hazard, assigned to a GHS hazard class and category. Some lower level hazard categories do not use signal words. Only one signal word corresponding to the class of the most severe hazard should be used on a label.

3. GHS Hazard Statement: Standard phrases assigned to a hazard class and category that describe the nature of the hazard. An appropriate statement for each GHS hazard should be included on the label for products possessing more than one hazard.

4. GHS Precautionary Statements: Measures to minimize or prevent adverse effects. There are four types of precautionary statements covering prevention, response in cases of accidental spillage or exposure, storage, and disposal. The precautionary statements have been linked to each GHS hazard statement and type of hazard.

5. Product Identifier (ingredient disclosure): Name or number used for a hazardous product on a label or in the SDS. The GHS label for a substance should include the chemical identity of the substance. For mixtures, the label should include the chemical identities of all ingredients that contribute to acute toxicity, skin corrosion

or serious eye damage, germ cell mutagenicity, carcinogenicity, reproductive toxicity, skin or respiratory sensitization, or Specific Target Organ Toxicity (STOT), when these hazards appear on the label.

6. Supplier Identification: The name, address and telephone number should be provided on the label.
7. Supplemental Information: Non-harmonized information on the container of a hazardous product that is not required or specified under the GHS. Supplemental information may be used to provide further detail that does not contradict or cast doubt on the validity of the standardized hazard information.

Detailed regulations and standards can be found within the following documents of the United States Occupational Safety and Health Administration (OSHA):
Hazard Communication (29 CFR 1910.1200)
Occupational Exposure to Hazardous Chemicals in Laboratories (29 CFR 1910.1450)

F. OSHA REGULATED CHEMICAL CARCINOGENS

The following carcinogens are strictly regulated and their handling, use and / or storage should be discussed with the Chemical Hygiene Officer before use. The thirteen specific chemicals that OSHA lists as posing the highest cancer hazard to humans arelisted in the table below, however these are not the only carcinogens that should be handled with caution.

CHEMICAL NAME	CHEMICAL ABSTRACT SERVICE REGISTRY NUMBER
4-Nitrobiphenyl	CAS No. 92-93-3
alpha-Naphthylamine	CAS No. 134-32-7
methyl chloromethyl ether	CAS No. 107-30-2
3,3'-Dichlorobenzidine (and its salts)	CAS No. 91-94-1
bis-Chloromethyl ether	CAS No. 542-88-1
beta-Naphthylamine	CAS No. 91-59-8
Benzidine	CAS No. 92-87-5
4-Aminobiphenyl	CAS No. 92-67-1
Ethyleneimine (Aziridine)	CAS No. 151-56-4
beta-Propiolactone	CAS No. 57-57-8
2-Acetylaminofluorene	CAS No. 53-96-3
4-Dimethylaminoazo-benzene (Methyl yellow)	CAS No. 60-11-7
N-Nitrosodimethylamine	CAS No. 62-75-9.

Table 5. OSHA Listed Carcinogens Standard 1910.1003

Chemicals and mixtures that meet the criteria of a listed carcinogen are classified as highly toxic and cancer causing substances. These substances should be handled with extreme caution using all basic laboratory practices, such as working only in chemical fume hood and wearing all appropriate PPE based on the specific hazards of each chemical. **A less hazardous alternative or chemical should be substituted whenever possible**. Additional safe handling and storage requirements apply when working with OSHA Listed Carcinogens cannot be avoided.

1. Precautions for Safe Handling and Storage of Listed Carcinogens

1. Permanent storage and handling areas should be established. Hazardous chemicals should be immediately tightly closed and returned to designated storage area after each use.

2. Handling and storage areas, as well as chemical containers must be clearly labeled with the chemical's name, CAS number and hazards.
3. Access to these chemicals should be restricted to individuals that have received proper instruction on safe handling and disposal. A lockable cabinet is the preferred method to store highly toxic chemicals.
4. All glassware and other laboratory equipment must be cleaned of residual chemicals immediately after use or be of a disposable nature.
5. Waste (including measuring devices, and napkins) containing even trace amounts of listed carcinogens must be clearly labeled as carcinogenic waste and submitted for disposal immediately.
6. Waste materials containing any amount of these substances should never be mixed with non-toxic chemical waste or general household waste.
7. The NFPA door signage on each laboratory entrance must contain a cancer warning statement as well as the specific name and CAS number if any one of these chemicals are stored within the lab space.
8. In case of exposure on person immediately remove all contaminated clothing and rinse areas for a minimum of 15 minutes under a safety shower and get medical attention immediately
9. In case of a spill or other accidental release the area should be immediately evacuated by all personnel.
10. All spills, regardless of size or personal exposure, must be reported to EHSRM and Lab Safety immediately. Laboratory personnel should not attempt to clean up spills of these chemicals without assistance.

Note: Excerpt from OSHA standard 1910.1003. Any mixture containing any of the above listed substances shall be considered carcinogenic if it is composed of:

Solid or liquid mixtures containing ≤ 1% by weight or volume of 4-Nitrobiphenyl; methyl chloromethyl ether; bis-chloromethyl ether; beta-Naphthylamine; benzidine or 4-Aminodiphenyl alpha-Naphthylamine; 3,3'-Dichlorobenzidine (and its salts); Ethyleneimine; beta-Propiolactone; 2-Acetylaminofluorene; 4-Dimethylaminoazobenzene, or N-Nitrosodimethylamine. [1910.1003(a) (2)]

G. PEROXIDE FORMING CHEMICALS

Peroxides have the tendency to explode readily and violently, and are capable of causing serious injury or death. Certain chemicals commonly found in the laboratory are capable of forming dangerously explosive levels of peroxides at varying rates and under different conditions (i.e. varying oxygen and temperature levels, presence of UV light and concentration). Over time, some chemicals will continue to increase peroxide levels to dangerous, heat or shock sensitive levels. Whereas other substances will not usually accumulate potentially explosive concentrations of peroxides, unless the volatile organic material is reduced in volume through evaporation or distillation.

While ethers are the most notorious and well-known PFCs, many other peroxidizable organic materials can be found; these include acetals, certain allyic alkenes (olefins), chloro- and fluoroalkenes, dienes, aldehydes, amides, lactams, ureas, some alkylarenes, ketones, vinyl monomers, and some alcohols.

Most liquid PFCs can be purchased with an added stabilizer or inhibitor to minimize peroxide formation, however distillation of the stabilized liquid removes the stabilizer. Furthermore, high-performance liquid chromatography (HPLC) grade solvents generally contain no stabilizer when purchased. In these cases, extreme care should be taken and the liquids must be carefully stored and monitored for peroxide formation.

Unsaturated monomers may autopolymerize as a result of peroxide accumulation if inhibitors are not present, have been removed or are depleted. These chemicals are prone to free radical polymerization that on exposure to air can form peroxides capable of initiating violent polymerization. Note that care must be taken when storing and handling these monomers; if present, most of the inhibitors used to stabilize these compounds require the presence of oxygen to function properly.

The first step in safe handling of these chemicals is to recognize them as peroxide formers and adhere to all safety protocols, including periodic testing for the **presence** of peroxides, storage requirements, and disposable. PFCs can be broadly categorized into four separate classes:

Class A. Severe Peroxide Formation Hazard. Spontaneously decompose and become explosive with exposure to air due to continuous buildup of peroxide levels.

Class B. Concentration Hazard. Require external energy for spontaneous decomposition. Form explosive peroxides when distilled, evaporated or otherwise concentrated.

Class C. Shock and Heat Sensitive. Highly reactive, auto-polymerize from internal peroxide accumulation. The peroxides formed in these reactions are extremely shock- and heat-sensitive.

Class D. Potential Peroxide Forming Chemicals. Other chemicals and substances that may form peroxides but are not easily categorized under A, B or C.

The following table lists the suggested time table for testing of peroxides and different classes of peroxide forming compounds. Suggested time limits are given for testing of these compounds. However, it must be noted that these shelf life durations are minimum criteria, -more frequent testing of all peroxide formers is recommended. A more detailed list of peroxide formers can be found in Appendix II.

CLASS A – SEVERE PEROXIDE FORMATION HAZARD			
Discard or Test After	**Examples**		
3 MONTHS Do not test if crystallized solids are observed.	Butadiene (liquid monomer)	Chloroprene (liquid monomer)	Tetrafluoroethylene (liquid monomer)
	Divinyl ether	Potassium amide	Sodium amide
	Isopropyl ether	Potassium metal	Vinylidene chloride
CLASS B – CONCENTRATION HAZARD			
Discard or Test After	**Examples**		
12 MONTHS	Acetal	Dicyclopentadiene	Methyl isobutyl ketone
	Acetaldehyde	Diethyl ether	2-Pentanol
	Benzyl alcohol	Dioxanes	Tetrahydrofuran (THF)
	2-Butanol	Furan	Tetrahydronaphthalene
	Cyclohexanol	4-Heptanol	Vinyl ethers
	Cyclohexene	2-Hexanol	Other secondary alcohols
CLASS C – SHOCK AND HEAT SENSITIVE PEROXIDE FORMERS			
Discard or Test After	**Examples**		
INHIBITED - 12 MONTHS **UNINHIBITED – 24 HRS**	Acrylic acid	Chloroprene	Vinyladiene chloride
	Acrylonitrile	Methyl methacrylate	Vinyl pyridine
	Butadiene (gas)	Styrene	Several more
	Chlorobutadiene	Vinyl acetate	
CLASS D – OTHER POTENTIAL PEROXIDE FORMERS			
Discard or Test After	**Examples**		
VARIES - 12 MONTHS or AS SDS REQUIRED	Acrolein	Diethoxyethane	Oximes
	Cyclooctene	Most Ethers	1-Pentene
	2-Chlorobutadiene	2-Ethoxyethyl acetate	Phenoxyacetyl chloride
	Chloroethylene	1-Ethoxynaphthalene	p-Phenylphenetone
	Diethyl fumarate	Methyltetrahydrofuran	Tetrahydropyran
	Diethoxybenzene	1-Octene	many more

Table 5. Recommended testing dates for peroxide forming chemicals.

1. General Precautions for the Storage and Handling of Peroxide Forming Chemicals

1. Keep only a minimum needed quantity of peroxides or peroxide forming chemicals on hand
2. Know the properties and hazards of all chemicals you are using through adequate research, including manufactures label and SDS.
3. Label each container with the Date Received, Date Opened and Date Last Tested.

4. Segregate these compounds from incompatible materials. Store away from ignition sources. Protect from flames, static electricity, and sources of heat.
5. Test chemicals for presence of peroxides before any distillation or purification of peroxide forming chemicals occurs.
6. Use extreme caution before concentrating or purifying peroxide forming chemicals as most explosions occur during these processes.
7. Minimize peroxide formation in ethers by storing in tightly sealed containers in a cool place in the absence of light.
8. If solids or crystals are observed in either the liquid or around the cap of peroxide forming chemicals, do not open or move the container; contact EHSRM for disposal.

Testing Peroxide Forming Chemicals

<u>Warning: Do NOT test Class A PFCs shows crystal formation within or on the outside of the container. Contact your safety coordinator.</u>

The following tests detect most (but not all) peroxy compounds, including all hydroperoxides:

- Peroxide test strips, which turn to an indicative color in the presence of peroxides, are available thru Lab Safety. Note that these strips must be air dried until the solvent evaporates and exposed to moisture for proper indication and quantification.
- Add 1 to 3 mL of the liquid to be tested to an equal volume of acetic acid, add a few drops of 5% aqueous potassium iodide solution, and shake. The appearance of a yellow to brown color indicates the presence of peroxides. Alternatively, addition of 1 mL of a freshly prepared 10% solution of potassium iodide to 10 mL of an organic liquid in a 25-mL glass cylinder produces a yellow color if peroxides are present.
- Add 0.5 mL of the liquid to be tested to a mixture of 1 mL of 10% aqueous potassium iodide solution and 0.5 mL of dilute hydrochloric acid to which has been added a few drops of starch solution just prior to the test. The appearance of a blue or blue-black color within 1 minute indicates the presence of peroxides.

None of these tests should be applied to materials (such as metallic potassium) that may be contaminated with inorganic peroxides.

2. Removal of Peroxides

<u>Peroxide removal should only be done by a qualified faculty member.</u>

Relatively low levels of peroxides (less than 100 ppm). warrant the removal (scrubbing) of peroxides rather than disposal of the entire quantity of solvent. Scrubbing of concentrations greater than 100 ppm may pose an unacceptable hazard, depending on the chemical involved. Scrubbing of discolored, crystallized, or layered peroxide formers should never be attempted. For chemicals with peroxide concentrations >100 ppm, notify EHSRM immediately for safe disposal.

Method 1

Hydroperoxides can be removed by passing the solvent through a column of activated alumina. This method works for water-soluble and water-insoluble chemicals. The washed solvent should be retested to ensure that peroxide have been removed. While alumina catalyzes the degradation of some peroxides, in other cases the peroxide may remain intact on the alumina, making it potentially shock sensitive. The alumina should be deactivated by flushing with a dilute acid solution of ferrous sulfate (description below). The amount of alumina required depends on the quantity of peroxide present. An initial 1:1 ratio (weight/volume) of alumina to solvent is generally adequate. Additional alumina or treatment through a second column may be required to eliminate all peroxides. While costly and slow this method minimizes shaking and introduction of water to the solvent. However, this method may not reliably remove dialkyl peroxides.

Method 2

Peroxides in water-insoluble chemicals can be removed via extraction with a concentrated solution of ferrous salt; 12 g $FeSO_4$, 12 mL concentrated H_2SO_4, and 210 mL water are a standard solution. The solvent is to be extracted two to three times with an equal aliquot of reagent and dried over sodium or magnesium sulfate. This method is reasonably effective for most peroxides, but it is not reliable for removing alkyl peroxides.

H. PERCHLORIC ACID

Perchloric acid can be dangerously reactive. Aqueous perchloric acid at concentrations less than 70% at room temperatures is a strong acid. At elevated temperatures or concentrations greater than 70% it is a strong oxidizing agent and can cause violent explosions if misused. Anhydrous perchloric acid (greater than 85%) is unstable even at room temperatures and ultimately decomposes spontaneously with a violent explosion. Contact with oxidizable material can cause an immediate explosion.

Follow these guidelines for the proper use of perchloric acid in the laboratory:

a. Perchloric acid in concentrations greater than 70% is not recommended.

b. Any procedure involving heating of perchloric acid must be conducted in a properly functioning perchloric acid fume hood with the sash down.

c. Do not allow perchloric acid to come into contact with organic material or dehydrating agents.

d. Anhydrous perchloric acid should only be made as required and should never be stored.

e. Only experienced faculty or fully trained and experienced laboratory personnel should handle anhydrous perchloric acid. Laboratory Safety Manager must be contacted prior to any work with anhydrous perchloric acid.

f. Do not allow contact with metals to prevent the formation of metal perchlorates which are very unstable and can explode.

g. Do not allow contact with wood or paper as fires can result from such contact.

I. HYDROFLUORIC ACID

Hydrofluoric acid (HF) is an extremely corrosive material. All forms, including vapors and solutions, can cause severe, slow-healing burns to human tissue, including the lungs and eyes. At concentrations greater than 50% the burning is noticeable in a matter of minutes or less, while at concentrations below 50% the burns may not be felt until several hours after exposure. Burns from concentrated acid involving as little as 2.5% of body surface have resulted in death. Because it has a low boiling point and a high vapor pressure, HF must be kept in a non-glass pressure container. HF dissolves glass; therefore, it should never be stored in a glass container.

Follow these guidelines for the proper use of hydrofluoric acid in the laboratory:

a. Have calcium gluconate available prior to acquiring or working with HF. Contact Laboratory Safety Division to obtain calcium gluconate.

b. Never work alone with HF.

c. Always use HF in a properly functioning fume hood. Heating of HF, or its solutions, requires an acid digestion fume hood.

d. In work involving HF, be sure to use materials that are compatible with HF. HF attacks a variety of materials, including glass, concrete, cast iron, wood, leather and rubber. Lead, wax, polyethylene, polypropylene and Teflon will resist its corrosive action.

e. In HF exposures, time is crucial. Immediately wash the affected area(s) with copious amounts of water to minimize the extent and the depth of the burn. Never let a HF burn go untreated, as extensive damage could result. Any area that is exposed to HF must be treated immediately with calcium gluconate or another appropriate material to stop its reaction with human tissue. Medical attention should be sought as quickly as possible. Ensure medical personnel are aware that HF is involved. Mistakes in treatment can occur if a miscommunication results in treatment for a hydrochloric acid burn instead of a hydrofluoric acid burn.

J. MERCURY

Mercury and its compounds are very common in laboratories. Elemental mercury is volatile, and its vapors are extremely toxic. Because of the vapors' high toxicity, it is very important to clean up mercury spills promptly and thoroughly. If this is not done, mercury can accumulate and vaporize over time. Inorganic and organic mercury compounds are also highly toxic, more so than elemental mercury, and should be handled with care.

Follow these guidelines for the proper use of mercury in the laboratory:

a. All work with elemental mercury should be performed over trays to capture and contain any spillage.

b. All work involving mercury should be done in a properly functioning chemical fume hood.

c. Clean up all mercury spills immediately. If you do not have the appropriate spill-control equipment, do not clean the spill yourself, as you can make the situation worse by creating small droplets that can end up in inaccessible locations such as cracks and crevices. For assistance, contact Laboratory Safety Division and/or EHSRM.

d. Be careful not to heat any surfaces that may contain mercury residue, as increased temperature greatly increases the vapor pressure of mercury.

e. Red spirit thermometers are a nontoxic alternative to mercury thermometers and should be used whenever possible.

K. DRY PICRIC ACID

Picric acid (trinitrophenol) must be stored hydrated as it becomes increasingly unstable when dehydrated. Dry picric acid is not only explosive but also sensitive to shock, heat and friction. Picric acid is highly reactive with a wide variety of compounds (including many metals) and is extremely susceptible to the formation of picrate salts. Be sure to label all containers that contain picric acid with the date received, and then monitor the water content every 6 months. Add distilled water as needed to maintain a consistent liquid volume. If picric acid is identified which has not been previously been accounted for or regularly checked do not handle the bottle. Perform a visual inspection only and note any crystallization, signs of evaporation, or the formation of solids in the bottle, do not handle the container and then immediately call Laboratory Safety on x8515. Secure access to the area where the bottle is located and wait for Laboratory Safety personnel to evaluate the container. Under no circumstances should laboratory personnel attempt to dispose of, or handle, dry picric acid.

L. CONTROLLED SUBSTANCES

For guidance on the storage and handling requirements for controlled substances please refer to the UTSA Controlled Substances Policy.

X. EMERGENCY RESPONSE

Laboratories can pose a number of hazards to personnel and each laboratory should be prepared in the event of an emergency such as serious injuries, fires, explosions, spills and exposure to hazardous material. Procedures should be risk assessed by experienced personnel and any potential emergencies planned for. Before beginning work in any laboratory personnel should know the location of the nearest spill kit, first aid kit, eyewash station, safety shower, fire extinguisher and fire alarm pull station. Personnel should also be familiar with how to use all these items. Environmental Health and Safety conduct regular training on the use of fire extinguishers and CPR and First Aid, all personnel are strongly encouraged to sign up for, and attend, these training classes. Personnel can contact the Laboratory Safety Division at any time for assistance with an incident, including non-serious accidents or spills.

All emergencies requiring immediate response must be reported to UTSA PD at x4911 on a campus phone or 210-458-4911 from a cell phone.

Accidents, exposures and spills must be reported to the Laboratory Safety Manager at x8515 as this enables the Laboratory Safety Division to ensure personnel receive any necessary assistance and follow up.

A. ACCIDENTS

In the event of accidents resulting in serious or life threatening injury or at weekends / after normal working hours call UTSA PD at x4911. Minor injuries can be treated temporarily with a First Aid Kit and personnel should then contact Occupational Health at 210-458-4038 for further treatment and advice. To ensure the safety of all personnel in the laboratory each lab should have the following within easy access:

1. First Aid Kit (checked regularly to ensure it is fully stocked)
2. Posting of all emergency contact numbers (a contact list can be found in Appendix VI and printed for use by labs).
3. SDS readily available in case of accidents involving chemicals.

All accidents must be reported to the Laboratory Safety Division (210-458-8515) and any employee of UTSA who suffers an accidental injury or occupational disease that arises out of, and in the course and scope of, employment should notify his or her supervisor to complete a first report of injury or illness form https://www.utsa.edu/safety/#/workplace within 24 hours. Accurate reporting of accidents and near misses allows Laboratory Safety to develop any recommendations and corrective actions that could prevent future incidents. Near misses can be reported anonymously through a web form at http://research.utsa.edu/research-funding/safety-committees/.

B. FIRES

In the event of a fire:

1. If the fire is small (for example a small trash can), and it is safe to do so, an appropriate fire extinguishers or sand can be used. Do not use water to extinguish fires.

For all other fires

1. Pull the closest fire alarm pull station and immediately evacuate the area.
2. Immediately notify UTSA PD x4911. Have the following information available:
    a. Any injuries
    b. Location of the fire (building name and room number)
    c. Potential explosion hazards present (e.g. gas cylinders or liquid nitrogen dewars)
    d. Your name and phone number
3. Remain outside the affected area and notify first responders of the details of the incident.
4. If the fire alarm is sounding, **you must evacuate the building**. Do not re-enter until you are notified that it is safe to do so by the Fire Department.

1. Fires involving clothing

1. Go to the nearest available emergency shower.
2. If a shower is not available follow: **STOP, DROP and ROLL** until flames are extinguished.
3. Fire extinguishers can be used to extinguish fires on a person.
4. Immediately contact UTSA PD x4911 for emergency assistance.

All fires, regardless of size, must reported to UTSA PD, the Laboratory Safety Division and EHSRM (x5250)

C. WORKER'S COMPENSATION INSURANCE (WCI) POLICY

1. For any work-related exposure reported to a supervisor or in which a supervisor has knowledge, an incident report should be completed and submitted to the EHSRM Occupational Health and WCI Coordinator (x5304 or x5250). Report Forms are available on the EHSRM website at http://utsa.edu/safety/. An employer should keep record of the employee's medical surveillance to ensure WCI coverage should the exposure result in an injury or disease
2. Note: An exposure does not meet the definition of an injury. UT System therefore cannot, under the TWCC Act, cover expenses incurred from an exposure unless the exposure results in an actual injury. UTSA however, has established funding to cover needle sticks and similar exposures. Contact the Occupational Health & WCI Coordinator at x5304 or x5250.
3. Medical surveillance under the direction of a licensed physician must be paid at no cost to the employee for work related injuries if:
    a. The employee exhibits signs or symptoms associated with exposure to a hazardous chemical used in the laboratory.
    b. A spill, leak or explosion occurs resulting in the likelihood of a hazardous exposure.
    c. Any employee is exposed routinely above the action level, or in the absence of an action level, above the permissible exposure limit for which there are exposure monitoring or medical surveillance requirements.

    d. If the employee is a student, they can be seen by the UTSA Student Health Services. If further examination by a physician is required, the student will be referred. The first report of injury form will still be required by EHSRM/LSD as well as follow-up documentation.

4. The laboratory supervisor or his/her representative should provide the physician with the identity of the chemicals, description of exposure conditions and symptoms, if any. The physician's opinion must be written and include any need for follow-up, results, any increased risk and a statement that the employee has been notified of the previous items.

D. Worker's Compensation Insurance (WCI) and Reporting Injuries or Illness on the Job

1. An employee of UTSA who suffers an accidental injury or occupational disease that arises out of, and in the course and scope of, employment should notify his or her supervisor to complete a first report of injury or illness form http://utsa.edu/safety/ within 24 hours. If an employee's injury is found to be compensable under the WCI Program, the employee is entitled to healthcare reasonably required by the nature of the compensable injury.

2. Injuries or chemical exposures that result in the hospitalization of 5 or more employees or the death of any one employee are to be reported to both the UTSA Police and Office of EHSRM immediately. EHSRM and Police personnel will ensure proper authorities are notified.

3. Responsibilities to the injured employee include:

    a. Notify the injured employee that his or her injury may be covered under worker's compensation insurance.

    b. Arrange for appropriate treatment in an emergency situation (keep in mind that an injured employee has a right to select his or her own healthcare provider).

XI. GENERAL CHEMICAL SPILL GUIDANCE

A quick response to spills is vital to mitigate the impact on personnel, property and the environment. Laboratory personnel should not hesitate in contacting the Laboratory Safety Division and EHSRM in the event of a spill, regardless of size, that they cannot manage. If the spill occurs after normal working hours or at weekends contact UTSA PD who can then contact Laboratory Safety Division and EHSRM personnel.

All laboratories are required to have a Chemical Spill Kit readily available in the event of a spill.

Steps to prevent or minimize the risk of a spill:

1. Good housekeeping – maintain a tidy, organized work space.
2. Perform a procedure review prior to conducting a new experimental procedure.
3. Store liquid chemicals in a secondary containment bin.
4. Keep reagent containers sealed or closed at all times, except when removing contents.
5. Order reagent chemicals in non-glass or coated glass containers whenever it is practical to do so.
6. Use secondary containment and carts when moving chemicals between locations.

A. SPILL KITS

All laboratories are required to have a chemical spill kit easily available to laboratory staff. Spill kits should be tailored to the specific hazards within the laboratory and it is strongly recommended that disposable supplies are used when possible as contaminated materials, following a cleanup, will be considered hazardous waste. Spill kit contents should be held in a chemical-resistant container. PPE contained in the spill kit must be selected based on the hazardous materials used. Hazardous materials users should know where to locate the spill kit and how to use the spill response materials contained in the kit.

2. Basic Spill Kit Supplies

1. **Container**

Obtain a chemical-resistant container to hold the kit contents such as a 5-gallon plastic bucket or Rubbermaid™ tub. It is recommended that an additional 5-gallon container be on hand that has a sealable lid.

2. **Personal Protective Equipment (minimum)**
   - 2 pairs chemical splash goggles.
   - 2 pairs chemical-resistant gloves. Silver Shield®/4H® and thick nitrile or neoprene gloves are recommended.
   - 2 pairs plastic, vinyl or rubber shoe covers.
   - 2 disposable lab coats, aprons, or coveralls.
3. **Absorption Materials**

Include universal absorbents such as commercial spill pads, pillows, spill socks, vermiculite and other loose absorbents. Examples of commercial universal absorbents are MagicSorb™, Wyk® Safety Sorbent, 3M™ Chemical Sorbent, Chemsorb®, Pig® Absorbent Pads, or Hazorb®.

4. **Cleanup Tools and Materials**

- Plastic scoop, dust pan, or shovel. Use plastic (polypropylene) when non-sparking tools are needed.
- Plastic broom or brush for solids (polypropylene).
- 3-5 thick, heavy duty waste bags. DO NOT use red biohazard waste bags for non-biohazard spill debris.
- Cardboard box to hold waste bag containing spill debris.
- Sealing tape.
- EHS hazardous waste labels.
- Forceps or tongs for picking up broken glass or other sharps.
- Detergent or general cleaner for final cleanup.

5. **Additional Spill Response Items as Necessary for Your Work Area**

- Additional PPE such as face shields, chemical-resistant clothing or boots.
- Neutralizing agents
    - General neutralizing agents for acids and bases
    - Chemical-specific neutralizers such as those for formaldehyde
    - Mercury spill response items
    - Specialized supplies for air or water-reactive chemicals and hydrofluoric acid.
    - Bleach, if biological agents are used.

Contact the Laboratory Safety Division if you require any assistance in building a spill kit appropriate for the hazards in your laboratory.

B. GENERAL SPILL GUIDANCE

For safe spill management it is important to determine if a spill is manageable by laboratory personnel or is unmanageable and requires assistance. Minor, manageable spills include small amounts of spilled material and non-hazardous substances that are easily contained with the supplies at hand. Major or unmanageable spills are never to be cleaned up by lab personnel.

Spill response plans should be prepared by each laboratory and form a part of the standard training in each laboratory. The Laboratory Safety Division is available to assist with the development of lab specific plans and can be contacted at any time an individual needs assistance in managing an incident.

C. UNMANAGEABLE SPILLS

There are several circumstances in which laboratory personnel should not attempt to handle a spill alone or without the assistance of Laboratory Safety, EHSRM or San Antonio Fire Department HAZMAT team. These include:

1. Any circumstance where the individual does not feel comfortable or sufficiently trained to manage the spill incident.
2. Spills greater than 500ml of any hazardous material (50ml of explosive and highly reactive chemicals).
3. Spills involving multiple or unknown chemicals.
4. Spills that are an immediate threat to lab personnel, students, the public, the environment or building infrastructure.
5. Spills that involve infectious agents, radioactive materials, corrosives, highly toxic or reactive chemicals.
6. Spills that show signs of reactivity (gas evolution, smoke, heat).
7. Leaking Gas Cylinders, venting either toxic, corrosive, oxidizing or flammable gasses
8. Spills that exceed the material or capacity of the in-lab spill kit or require additional PPE (self-contained breathing apparatus, respirator or Hazmat Suit)
9. A spills that show signs of unexpected reactivity (gas evolution, smoke, heat)
10. The spill may endanger the environment by reaching drains or outside ground
11. Circumstances where a minor spill was handled incorrectly and the hazard increased.

1. Response to unmanageable spills

1. Evacuate the affected area and alert all others nearby to evacuate.
    a. Remove any injured or contaminated persons if you can do so safely.
2. Contact UTSA PD (or 210 458 4911) and have following information on hand:
    a. Any injuries
    b. Location of the spill (building name and room number)
    c. Name of the chemical spilled
    d. Approximate quantity of the chemical spilled
    e. Any fire or explosions hazard present
    f. Your name and phone number
3. Arrange for someone to meet the emergency responders.
4. Secure the area at a safe distance with signs and warning tape, or post staff to prevent anyone from entering the affected area before the emergency responders arrive.

Emergency Contacts for Unmanageable Spills (24hrs)

UTSA POLICE DEPARTMENT	210-458-4911 (from a cell phone or off campus phone) 4911 (from a university phone)
LABORATORY SAFETY MANAGER (CHO)	210-458-8515 (from a cell phone or off campus phone between 8am – 5pm) 8515 (from a university phone between 8am – 5pm) 210-294-3342 (after hours and weekends)

It is not recommended that lab personnel attempt cleanup of spills involving chemicals in Table 6 below without the assistance of Laboratory Safety or EHSRM. In the case of a spill with any of the chemicals below contain the spill with an appropriate absorbent material then immediately alert Lab Safety and EHSRM for further assistance.

CHEMICAL CLASS	EXAMPLES
Strong Acids – Any acid that is concentrated enough to fume or emit acid gases	Fuming Sulfuric Acid Red Nitric Acid Hydrofluoric Acid Perchloric Acid
Strong Bases – Any base that is concentrated enough to emit vapors	Ammonium hydroxide
Poisonous by Inhalation – Any chemical that readily emits vapors / gases at normal temperature and pressure that are extremely toxic by inhalation	White Phosphorous Oxychloride Titanium tetrachloride Formates Isocyanates
Reactive – Any chemical that is sensitive to air, water, shock, friction and/or temperature	Dry Picric Acid Phosphorous metal
Extremely Toxic – Any chemical that is readily absorbed through the skin and is extremely toxic at small concentrations	Sodium cyanide
OSHA Listed Carcinogens	Refer to OSHA list

Table 6. Chemical spills that require assistance from Laboratory Safety and EHSRM.

D. MINOR AND MANAGEABLE SPILLS

Minor spills do not pose an immediate threat to health or environment and should be cleaned up by laboratory personnel immediately. Due to the complexity and nature of minor spills no single response plan or clean up procedure will work for all circumstances. General steps take must be adapted to the presented hazard of the spill. However, certain immediate steps take precedence over others, and should be followed when cleaning up a minor spill. Never assume that a situation or spill will remain minor if mismanaged or additional factors come into play. If the threat from a minor spill evolves to dangerous levels immediately evacuate the area call UTSA PD for further assistance with the situation.

1. Response for Minor Spills

1. Alert others nearby to warn them of the spill.

2. Put on PPE (lab coat, gloves, safety goggles).

3. Neutralize or absorb liquid spills using appropriate material for the spilled chemical as outlined below under "**Spill clean-up procedures for specific spills**". Carefully sweep powder spills to avoid contaminating the air with chemical dust.
4. Sweep up spilled material using a broom and dustpan or inert absorbent pads and put the material into a heavy-duty plastic bag or a container with lid.
5. Wash the affected area thoroughly with soap and water and ventilate the area if necessary.
6. Dispose of spilled material as hazardous waste. Questions regarding chemical waste disposal should be addressed to EHSRM or Lab Safety.
7. All spills regardless of size or nature should be reported to Lab Safety for response evaluation and training purposes.

BEST PRACTICE

Spill control material should be applied over the entire area of the spill, working from the outside inwards. This reduces the chance of splash or further spread of the spilled chemical. Small amounts of color changing indicators may be added to the neutralizing material to indicate when the reaction has finished and can be safely swept up and submitted for disposal.

XII. HAZARD SPECIFIC SPILL GUIDANCE

A. FLAMMABLE LIQUIDS

Use non-flammable absorbent pillows or pads, or inert absorbent powder:

1. Cover the spill with absorbent material to suppress vapors.
2. Once the liquid is absorbed, place the absorbent material into a sturdy plastic bag or bucket, seal the bag or container, and dispose of as flammable waste through EHSRM
3. The spill area can then be cleaned with soap and water.

Do NOT use paper towels to absorb flammable liquids because they add combustible material to the spill. Do NOT leave absorbent pads or materials under a fume hood to evaporate the solvent before disposal.

B. CORROSIVE LIQUIDS

Neutralize the corrosive liquid before clean-up because it may break down general purpose spill pads:

- Acids: sodium bicarbonate, calcium carbonate, or commercially available acid neutralizer.
- Hydrofluoric acid: calcium carbonate or commercially available hydrofluoric acid neutralizer.
- Bases: citric acid, sodium bisulfate, or commercially available base neutralizer.

1. Sprinkle the powder at the edges of the spill and work to the center. Be careful because the neutralization process can be vigorous, causing splashes and yielding large amounts of heat.
2. After the initial reaction has taken place move the neutralizer around using a spatula and make sure all the corrosive chemical has reacted. Add more neutralizer as needed.
3. Scoop up the neutralized spill and place it into sturdy plastic bag or container with lid, and dispose of as hazardous waste.

C. WATER REACTIVE AND PYROPHORIC STRONG BASES

Do not use paper towels, cloth, vermiculite or other combustible materials, as these can ignite in contact with the reactive material. Never use water when cleaning up a spill of pyrophoric or water reactive material. The exception is a spill on a person or ignited clothing/skin. In these cases, rinsing away unreacted chemical is of primary importance. If you feel uncomfortable or are unsure of the spill situation do NOT attempt to clean-up of the spill on your own. Call UTSA PD at x4911 and leave the affected area.

1. In the event of a spill, ensure other lab personnel are immediately aware of the incident
2. Eliminate all nearby ignition sources and locate an appropriate fire extinguisher in case the spill ignites. For water reactive and pyrophoric strong bases use only dry chemical-based extinguishers (class ABC or D). Under no circumstance should a water or CO_2 extinguisher be used.
3. If the spill is inside a fume hood cover the spill with excess dry sand or other non-combustible material. Close the fume hood sash and purge the fume hood if a purge button is present. If purge is not possible, immediately call Lab Safety and EHSRM to assist with disposal of contaminated material.

4. If the spill occurred outside of the fume hood cover with excess dry sand or other non-combustible material (vermiculite is **not** appropriate). Call Lab Safety and EHSRM for assistance with disposal of contaminated material. If materials are available the spilled material may be collected with plastic tools and transferred to a plastic container with a loosely fitting lid prior to the arrival of safety personnel. However, if in doubt wait until assistance arrives.
5. If the spill ignites, and only if you are trained and feel comfortable in doing so, a dry chemical fire extinguisher (class ABC or D) may be used to extinguish. If in doubt immediately evacuate the area and pull the fire alarm and notify UTSA PD at x4911 of the situation.

D. ALKALI METALS (LITHIUM, SODIUM, POTASSIUM)

Due to their reactivity avoid contact with water:

1. Use tweezers to quickly pick-up the metal and put it into a container of mineral oil.
2. Make sure the container holds enough oil so that all metal is fully submerged.
3. Close the container and dispose of as metal waste.

If a fire occurs, smother with sand or extinguish with a Class "D" fire extinguisher. **If the fire cannot be controlled close the fume hood, evacuate the area and contact emergency**

E. BROMINE

Due to the inhalation hazard of bromine only attempt to clean up spills inside a chemical fume hood. If the spill is outside the hood, the area should be evacuated and emergency responders should be called.

1. Neutralize spills inside the hood with a 5-10% solution of sodium thiosulfate if safe to do so.
2. Wash the contaminated area several times with the sodium thiosulfate solution to completely decontaminate.
3. Clean up the resulting solution with an absorbent pad.

F. MERCURY

Elemental mercury has no detectable odor however can create harmful vapors. The vapor generation will increase in the presence of heat.

Special materials needed for a mercury spill

Suction device – Pasteur Pipette

Mercury sponge and container

Double Nitrile gloves (recommended)

1. Small spills – for example a broken thermometer

1. Stabilize the spill without contaminating yourself and isolate the area to prevent others from coming in contact with the spill and enlarging the spill area.
2. Keep mercury away from sinks and drains.

3. Do not touch or walk through spilled material. Do not disturb it until ready to clean it up.
4. Determine if the surface is porous (such as carpet, upholstery, or fabric) or non-porous (sealed wood, vinyl, and linoleum). Observe the area for cracks, crevices or other places where mercury can collect.
5. Plan and conduct the clean-up.
6. Do not use a broom. The mercury will break up, spread, and generate vapor.
7. Do not use a vacuum! Ordinary vacuums will spread the spilled mercury and generate vapor. The vacuum will also become contaminated and will be considered hazardous waste

2. Non-Porous Surfaces

1. Carefully pick up any broken glass. Sharps such as broken thermometers that have contained, or still contain mercury, must be placed in a separate container and labeled as mercury-containing hazardous waste.
2. Working from the edge of the spill inward, use a card or scraper to push the mercury droplets together into a larger drop.
3. Aspirate larger droplets using a suction device such as a Pasteur pipet or syringe with no needle and carefully transfer the droplets directly into a plastic container with a sealable lid (screw-top vial, empty plastic jar, film canister, etc.)
4. Use the suction device to get material out of cracks.
5. Pieces of masking tape or duct tape may be used to pick up tiny droplets.
6. An anti-static spray may help to release tiny droplets.
7. Use a flashlight in reduced-light areas to detect missed mercury. Scan parallel to the floor.
8. A mercury sponge may be used to take up small amounts of material on flat surfaces. Follow directions included with the kit.
9. Commercial mercury-absorbent powder may be used to amalgamate remaining residue. Sprinkle powder over area, spray with water mist or recommended activator, scrape into a paste, and wipe up with damp paper towels.
10. Commercial mercury “wipes” may be used as a final step to remove residue from cleaned surfaces.
11. Place all trash, PPE, etc, into a zip-tip bag or a plastic waste bag. Double bag and secure, then place into a box. Seal the box and affix a hazardous waste label identifying the material as “mercury spill debris.”

3. Porous Surfaces

1. Contaminated items should be disposed of as hazardous waste.
2. Affected area of a carpet may be cut out and replaced.
3. Seek advice from EHSRM if mercury is spilled on other porous surfaces

G. HAZARD SPECIFIC NEUTRALIZERS

Spilled Substance	Manageable Spills should be treated with:
Acids, organic	Apply sodium bicarbonate. Adsorb with spill pillow or vermiculite.
Acids, inorganic	Apply sodium bicarbonate/calcium oxide or sodium carbonate/calcium oxide. Adsorb with spill pillow or vermiculite. NOTE: Hydrofluoric acid is an exception to the general practice, see below.
Acids, oxidizing	Apply sodium bicarbonate. Adsorb with vermiculite.
Acid Chlorides	Do not use water. Absorb with sand or sodium bicarbonate.
Bases (caustic alkalis)	Neutralize with citric acid, boric acid or tartaric acid or commercial chemical neutralizers. Absorb with spill pillow or vermiculite.
Cyanides	Cover solids with damp paper towel and push onto dust pan or use a HEPA filter vacuum to collect the solids. Absorb liquids with spill pillow or vermiculite.
Halides, organic or inorganic	Apply sodium bicarbonate.
Halogenated Hydrocarbons	Absorb with spill pillows or vermiculite.
Hydrazine	Avoid organic matter. Apply "slaked lime". Adsorb with spill pillow or vermiculite.
Hydrofluoric Acid	Apply calcium carbonate (limestone) or lime (calcium oxide) rather than sodium bicarbonate. The use of sodium bicarbonate will lead to the formation of sodium fluoride, which is considerably more toxic than calcium fluoride. Be careful in the use of spill pillows used to absorb the acid. Some pillows contain silicates which are incompatible with hydrofluoric acid.
Mercaptans/Organic Sulfides	Neutralize with calcium hypochlorite solution. Absorb with spill pillow or vermiculite.
Nitriles	Sweep up solids. Absorb liquids with spill pillows or vermiculite.
Nitro compounds Organic Nitriles	Absorb with spill pillow or vermiculite. Avoid skin contact or inhalation.
Oxidizing Agents	Apply sodium bisulfite.
Peroxides	Carefully add diatomite, or dry sand to the spill. Then slowly add water to wet the material.
Phosphates, organic and related	Absorb with spill pillow or vermiculite.
Reducing Substances	Apply soda ash or sodium bicarbonate.

Table 7. Hazard Specific Neutralizers.

XIII. APPENDIX I – CHEMICALS REQUIRING CSC REVIEW

The Chemical Safety Committee (CSC) has determined that the following compounds, due to the hazard level and risk to personnel and property, require submission of an individual protocol for review. Protocol templates for each compound can be found on the CSC website. Additional risk assesments may be required for other classes of chemicals. Based on your inventory the Laboratory Safety Division will assist you in completing and submitting these documents. Completed CSC templates serve as an additional form of laboratory specific training that P.I.s can use to supplement student training. The templates should be completed and submitted to the CSC office (csc@utsa.edu). For additional information please contact the CSC office on x8515 or x7733.

NAME	CAS NUMBER
Acetylene	74-86-2
Arsine	7784-42-1
Bis(chloromethyl) ether	542-88-1
Bis(2-chloroethyl) sulfide (Sulfur Mustard)	505-60-2
Cyanogen	460-19-5
Diazomethane	334-88-3
Diborane	19287-45-7
Diethylmercury	627-44-1
Dimethylmercury	593-74-8
Ethidium bromide	1239-45-8
Fluorine	7782-41-4
Hydrogen cyanide	74-90-8
Hydrofluoric acid (gas and liquid)	7664-39-3
Hydrogen sulfide	7783-06-4
Methacryloyloxyethyl Isocyanate	30674-80-7
Methyl fluorosulfonate	421-20-5
Methyl isocyanate	624-83-9 0004
Oxygen Difluoride	7783-41-7
Pentaborane	19624-22-7
Phosgene gas	75-44-5
Phosphine	7803-51-2
Picric Acid	88-89-1
Perchloric acid	7601-90-3
Selenium hexafluoride	7783-79-1
Strychnine (base)	57-24-9
Strychnine (Sulfate)	60-41-3
Sulfur pentafluoride, dimer	5714-22-7
Sulfur tetrafluoride	7783-60-0
Tellurium hexafluoride	7783-80-4

Tetracarbonylnickel	13463-39-3
Tetraethyllead	78-00-2
Tetraethyl pyrophosphate	107-49-3
Tetramethyllead	75-74-1
White phosphorous	12185-10-3

Table 8. Specific chemicals requiring review by the CSC before use.

XIV. APPENDIX II – COMMON PEROXIDE FORMERS

Listed below are some of the common peroxide formers with recommendations and requirements for testing frequency. Please contact the Laboratory Safety Division for testing strips and labels and any advice you may need on conducting tests.

Class A: Peroxide Hazard on Storage – Without Concentration

These chemicals can form peroxides that are difficult to detect and eliminate. Label these items with a date of receipt and date of opening and dispose of these items 3 months after opening or 12 months if unopened.

Name	Synonym(s)	CAS Number
Butadiene (liquid monomer)	Alpha-butadiene	106-99-0
Chloroprene (liquid monomer)		126-99-8
Divinyl ether	Vinyl ether; divinyl oxide; vinether; vinidyl; vinydan	109-93-3
Isopropyl ether	Diisopropyl ether	108-20-3
Potassium amide	Aminopotassium; Potassium azanide	17242-52-3
Potassium metal	Kalium	7440-09-7
Sodium amide (sodamide)		7782-92-5
Tetrafluoroethylene (liquid monomer)	Perfluoroethylene; Perfluoroethene; Ethene	116-14-3
Vinylidene chloride	1,1-Dichloroethylene	75-35-4

Class B - Concentration Hazard

Require external energy for spontaneous decomposition.
Form explosive peroxides when distilled, evaporated or otherwise concentrated.

Name	Synonym(s)	CAS Number:
Acetals	For example: Diethyl Acetal; Acetaldehyde diethyl acetal	105-57-7
Acetaldehyde	Ethanal; Acetic aldehyde; Ethyl aldehyde	75-07-0
Benzyl alcohol	Phenylmethanol; Benzenemethanol; Phenylcarbinol	100-51-6
2-Butanol	Sec-Butanol; Sec-Butyl Alcohol; 2-Hydroxybutane	78-92-2
Cumene	Isopropylbenzene; Cumol;	98-82-8
Cyclohexanol	Cyclohexyl alcohol; Hexahydrophenol; Hydrophenol; Hydroxycyclohexane	108-93-0
Cyclohexene	Tetrahydobenzene; Benzene tetrahydride	110-83-8
2-Cyclohexen-1-ol		822-67-3
Decahydronaphthalene (decalin)	Cis-Decahydronaphthalene; Trans-Decahydronaphthelene	91-17-8
Diacetylene (butadine, gas)		
Dicyclopentadiene	Cyclopentadiene dimer; Bicyclopentadiene; Biscyclopentadienel Dicyklopentadien	77-73-6
Diethylene glycol dimethyl ether (diglyme)		111-96-6
Diethyl ether (ether)	Ethyl ether; Ethoxyethane; Diethyl oxide; Ethyl oxide	60-29-7
Dioxanes	P-Dioxane; Diethylene ether	123-91-1

Ethylene glycol ether acetates (glyme)	Monoglyme; Ethylene glycol dimethyl ether; Dimethyl cellosolve	110-71-4
Furan	Divinylene oxide; Furfuran; Tetrole; Oxacyclopentadiene	110-00-9
4-Heptanol	Heptan-4-ol; Dipropylcarbinol	589-55-9
2-Hexanol	Hexan-2-ol; Sec-Hexyl alcohol	37769-60-1
Methylacetylene (gas)	Propyne; Allylene; 1-Propyne	74-99-7
3-Methyl-1-butanol	Isoamyl alcohol; Isopentyl alcohol; Isopentanol	123-51-3
Methyl cyclopentane	Cyclopentane; Methylpentamethylene	96-37-7
Methyl isobutyl ketone	Isopropylacetone; 4-Methyl-2-pentanone	108-10-1
4-Methyl-2-pentanol	4-Methylpentan-2-ol; Isobutylmethylcarbinol	108-11-2
2-Pentanol	Pentan-2-ol; Sec-Amyl alcohol; Methylpropylcarbinol; Sec-Pentyl alcohol	6032-29-7
4-Penten-1-ol	4-Pentenol; 4-Pentenyl alcohol; 2-Allylethyl alcohol	821-09-0
1-Phenylethanol	Alpha-methylbenzyl alcohol; Methylphenyl carbinol; Styralyl alcohol	98-85-1
2-Phenylethanol	Phenethyl alcohol; benzeneethanol; Phenylethyl alcohol; Benzyl carbinol	60-12-8
Tetrahydrofuran (THF)	Oxolane; Hydrofuran; Furanidine	109-99-9
Tetrahydronaphthalene (tetralin)	Benzocyclohexane; Bacticin	119-64-2
Vinyl ethers	DIVINYL ETHER; Divinyl oxide; Vinether; Vinidyl; Vinydan	109-93-3

Class C - Shock and Heat Sensitive

Highly reactive and can auto-polymerize as a result of internal peroxide accumulation. The peroxides formed in these reactions are extremely shock- and heat-sensitive.

Name	Synonym(s)	CAS Number
Acrylic acid	Propenoic acid; Vinylformic acid	79-10-7
Acrylonitrile	Propenenitrile; Vinyl cyanide	107-13-1
Butadiene (gas)	Divinyl; Vinylethylene	106-99-0
Chlorobutadiene	Chloroprene	126-99-8
Chloroprene	Chlorobutadiene	126-99-8
Chlorotrifluoroethylene (gas)	Daiflon; Chlorotrifluoroethene; Trifluorochloroethylene	79-83-9
Methyl methacrylate	Methacrylic acid methyl ester	80-62-6
Styrene	Ethenylbenzene; Phenylethylene; Vinylbenzene; Styrol	100-42-5
Tetrafluoroethylene (gas)	Perfluoroethylene; Perfluoroethene; Ethene	116-14-3
Vinyl acetate	Ethenyl acetate; Acetic acid ethenyl ester; Ethenyl ethanoate	108-05-4
Vinylacetylene (gas)	Butenyne; Monovinylacetylene	689-97-4
Vinylidiene chloride		75-35-4
Vinyl chloride (gas)	Chloroethylene; Chloroethene	75-01-4

Vinyl pyridine	2-Vinylpyridine	1337-81-1

Class D - Potential Peroxide Forming Chemicals

May form peroxides but cannot be clearly categorized in Class A, B, or C.

This group is extensive and includes all other ethers, and various other chemicals and substances containing an R-O-O-R’ structure. Some examples are listed below and a more extensive list can be found on the Laboratory Safety Division Website. Always refer to the SDS of the chemical you are using.

Name	Synonym(s)	CAS Number
Benzyl ethyl ether	Benzene ether; Ether benzene; Benzene diethyl ether	103-50-4
Benzyl methyl ether	Methoxymethylbenzene; Methyl Benzyl ether	538--86-3
Diallyl ether	Allyl ether	557-40-4
1,2-Dibenzyloxyethane	Ethylene glycol Dibenzyl ether; Dibenzyl glycol	622-22-0
p-Dibenzyloxybenzene	Hydroquinone dibenzyl ether	621-91-0
1,2-Dichloroethyl ethyl ether		623-46-1
2,4-Dichlorophenetole		5392-86-9
Ethylene glycol monomethyl ether	Methyl Cellosolve; Ethylene glycol monomethyl ether; Methyl oxitol	109-86-4
1-Octene	Caprylne	111-66-0
Tetrahydropyran	Oxane; Oxacyclohexane; Pentamethylene Oxide	142-68-7
1,1,2,3-Tetrachloro-1,3-butadiene	Tetrachlorobutadiene	921-09-5
Vinylene carbonate		872-36-6

XV. APPENDIX III – COMMON POTENTIAL EXPLOSIVES

Use of explosive compounds on campus requires review by the CSC, please contact the Laboratory Safety Division or the CSC office for an explosives protocol template.

NAME	CAS NUMBER	SYNONYMS
Acetyl peroxide	110-22-5	acetylperoxide; diacetyl peroxide; Peroxide, diacetyl; ethanoyl peroxide; acetyl ethaneperoxoate; ethanoyl ethaneperoxoate; peracetic acid acetyl ester
Acetylene	74-86-2	ethyne
Ammonium nitrate	6484-52-2	
Ammonium perchlorate	7790-98-9	AP
Ammonium picrate	131-74-8	Dunnite; Picratol; 2,4,6-Trinitrophenol ammonium salt; Ammonium picronitrate; Explosive D
Barium azide	18810-58-7	barium dinitride
Benzoyl peroxide	94-36-0	benzoperoxide, dibenzoyl peroxide (DBPO)
Bromopropyne (3-Bromoprop-1-yne)	106-96-7	3-Bromo-1-propyne, Bromopropyne, 1-Brom-2-propin, 1-Bromo-2-propyne, Gamma-bromoallylene, 1-Bromo-2-propyne, 2-Propynyl bromide, Propargyl bromide, Propynyl bromide, gamma-Bromoallylene

Butanone peroxide	1338-23-4	Methyl ethyl ketone peroxide,MEKP, 2-[(2-Hydroperoxybutan-2-yl)peroxy]butane-2-peroxol, 2-Hydroperoxy-2-[(2-hydroperoxybutan-2-yl)peroxy]butane, Ketonox, Mepox, Thermacure
Cumene hydroperoxide	80-15-9	Cumyl Hydroperoxide, CHP
Diazodinitrophenol	4682-03-5	
Dinitrophenol (6 isomers)		
2,3-Dinitrophenol	66-56-8	
2,4-Dinitrophenol	51-28-5	
2,5-Dinitrophenol	329-71-5	
2,6-Dinitrophenol	573-56-8	
3,4-Dinitrophenol	577-71-9	
3,5-Dinitrophenol	586-11-8	
Dinitrophenylhydrazine	119-26-6	2,4-DNPH, 2,4-DNP, Brady's Reagent, Borche's Reagent
Dinitroresorcinol	519-44-8	2,4-Dinitrobenzene-1,3-diol; 1,3-Benzenediol, 2,4-dinitro-;2,4-Diaminotoluene-A,A,A-D3;
Dipicryl amine	131-73-7	Hexanitrodiphenylamine;2,2',4,4',6,6'-Hexanitrodiphenylamine;Benzenamine, 2,4,6-trinitro-N-(2,4,6-trinitrophenyl)-;Bis(2,4,6-trinitrophenyl)amine;Hexyl;Bis(2,4,6-trinitro-phenyl)-amin;Diphenylamine, hexanitro-;Diphenylamine, 2,2',4,4',6,6'-hexanitro-;DPA;Esanitrodifenilamina;Hexamine;Hexamine (potassium reagent); Hexanitrodifenylamine; Hexyl (reagent);2,4,6-Trinitro-N-(2,4,6-trinitrophenyl)benzenamine;2,4,6,2',4',6'-Hexanitrodiphenylamine;Aurantia;
Dipicryl sulphide	2217-06-3	
Dodecanoyl peroxide	105-74-8	Lauroyl peroxide; Dilauroyl peroxide, Peroxide, bis(1-oxododecyl); Dodecanoyl peroxide; Laurydol
Ethylene oxide	75-21-8	Oxirane; ethylene oxide; Epoxyethane; 1,2-Epoxyethane; Oxacyclopropane; EtheneOxide; Dimethylene Oxide;
Heavy metal azides		
Hydrogen peroxide (70%)	7722-84-1	
Lauric peroxide		
Lead azide	13424-46-9	
Lithium azide	19597-69-4	
Mercury azide		
Mercury fulminate	628-86-4	Fulminated Mercury
Methyl ethyl ketone peroxide see butanone peroxide)	1338-23-4	
Nitrocellulose	9004-70-0	
Nitrogen trifluoride	Not an explosive	
Nitrogen trichloride	10025-85-1	Trichloramine, Agene, Nitrogen(III) chloride, Trichloroazan, Trichlorine nitride

Nitrogen tribromide	15162-90-0	
Nitrogen triiodide	13444-85-4	Nitrogen iodide, Ammonia triiodide, Triiodine nitride, Triiodine mononitride, Triiodamine
Nitroglycerine	55-63-0	Propane-1,2,3-triyl trinitrate, 1,2,3-Tris(nitrooxy)propane
Nitroguanidine	556-88-7	Picrite
Nitromethane	75-52-5	Nitrocarbol
Nitrourea	556-89-8	1-Nitrourea, N-Nitrocarbamide
Organic azides		
Picramide	489-98-5	2,4,6-trinitroaniline
Picric acid	88-89-1	Picric acid, Carbazotic acid, Phenol trinitrate, Picronitric acid, Trinitrophenol, 2,4,6-Trinitro-1-phenol, 2-Hydroxy-1,3,5-trinitrobenzene, TNP, Melinite
Picryl chloride, TNCB	88-88-0	2-Chloro-1,3,5-trinitrobenzene, 2,4,6-Trinitrochlorobenzene
Picryl sulphonic acid	2508-19-2	Picrylsulfonic acid; Trinitrobenzene sulfonate; TNBS
Potassium azide	20762-60-1	
Propargyl bromide (neat)	106-96-7	3-Bromo-1-propyne, Bromopropyne, 1-Brom-2-propin, 1-Bromo-2-propyne, Gamma-bromoallylene, 1-Bromo-2-propyne, 2-Propynyl bromide, Propargyl bromide, Propynyl bromide, gamma-Bromoallylen
Silver fulminate	5610-59-3	
Sodium azide	26628-22-8	
Sodium dinitrophenate	824-39-5	Sodium 2-nitrophenolate; Sodium o-nitrophenolate; 2-Nitrophenol Sodium Salt; O-Nitrophenol sodium salt;
Succinic peroxide		
Tetranitroaniline	3698-54-2	2,3,4,6-Tetranitroaniline; Tetranitraniline; Tetranitraniline [French]; Benzenamine, 2,3,4,6-tetranitro-; 3698-54-2; ANILINE,
Trinitroaniline see Picramide	489-98-5	2,4,6-Trinitroanisol; picric acid methyl ether; trisol; trinol; trinitroanisole
Trinitroanisole	606-35-9	
Trinitrobenzene	99-35-4	
Trinitrobenzenesulphonic acid see (Picryl sulphonic acid)	2508-19-2	
Trinitrobenzoic acid	129-66-8	
Trinitrocresol	602-99-3	3-methyl-2,4,6-trinitrophenol
Trinitronaphthalene	87185-24-8	2,3,5-Trinitronaphthalene; CCRIS 5343; 1,6,7-trinitronaphthalene; Naphthalene, 1,6,7-trinitro-; 87185-24-8; NAPHTHALENE,
Trinitrophenol see Picric Acid	88-89-1	Picric Acid
Trinitroresorcinol	82-71-3	syphnic acid;STYPHNIC ACID;Trinitroresorcine

Trinitrotoluene	118-96-7	2,4,6-Trinitromethylbenzene 2,4,6-Trinitrotoluene 2,4,6-Trinitrotoluol TNT Tolite Trilite Trinitrotoluol Trinol Tritolo Tritolol Triton Tritone Trotol Trotyl
Urea Nitrate		

Table 10. Common Explosives

XVI. APPENDIX IV – CONTROLLED GLASSWARE

Refer to the UTSA Controlled Substances Policy for more details.

The items listed below are considered controlled glassware. Laboratories may own and use the glassware listed below however these items must not be disposed of through surplus. Prior to discarding any of the following glassware items contact the CHO (x8515). Items may be re-distributed within the university however, the Laboratory Safety Division must know the location of the items.

Controlled Glassware
Condensers
Distilling apparatus
Vacuum dryers
Three-necked flasks
Distilling flasks
Tableting machines
Encapsulating machines
Soxhlet extractors
Transformers
Flask heaters
Heating mantles
Adapter tubes
Erlenmeyer flasks, two-necked flasks, single neck flasks, round-bottom flasks, Florence flasks, thermometer flasks, and filtering flasks
Filter funnels, Buchner funnels, and separatory funnels.

Any institution or site that discovers a readily unacceptable discrepancy, loss, pilferage or theft of controlled glassware) must notify the Laboratory Safety Division immediately. The CHO will then make the required written report of the incident to the appropriate law enforcement agency no later than 5 business days after the date of discovery of the discrepancy, loss, pilferage or theft.

XVII. APPENDIX V – MATERIAL COMPATIBILITY FOR GAS REGULATORS AND TUBING

The following table is adapted from the mathesontrigas.com guide for the compatibility of certain gases with commonly used regulator and tubing materials. The compatibility of materials is essential for the safe use of gases please consult with either the Laboratory Safety Division or your gas supplier if you have any questions.

✓ Gas is compatible at room temperature in pure form with the material recommended
X Should not be used with this gas
S Suitability depends on the conditions of use
- Insufficient data available, not recommended

	METALS						PLASTICS				ELASTOMERS		
	316 Stainless Steel	**Monel**	**Brass**	**Aluminum**	**Zinc**	**Copper**	**Kel-F**	**Teflon**	**Tetzel**	**Kynar**	**Viton**	**Buna-N**	**Neoprene**
Acetylene	✓	✓	✓	✓	X	X	✓	✓	✓	✓	✓	✓	✓
Air	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ammonia	✓	✓	X	✓	X	X	✓	✓	✓	X	X	✓	✓
Argon	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Arsine	✓	✓	✓	-	-	✓	✓	✓	✓	✓	✓	✓	✓
Boron Trichloride	✓	✓	S	X	-	✓	✓	✓	✓	-	-	-	-
Boron Trifluoride	✓	✓	S	✓	-	S	✓	✓	✓	-	-	-	-
Bromine Trifluoride	✓	✓	S	S	-	S	S	S	✓	X	X	X	X
1,3-Butadiene	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
n-Butane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1-Butene	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
cis-2-Butene	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
trans-2-Butene	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Carbon Dioxide	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	S	S
Carbon Monoxide	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Carbonyl Sulfide	✓	✓	✓	✓	-	✓	-	-	-	-	-	-	-
Chlorine	✓	✓	X	X	X	X	✓	✓	✓	✓	✓	X	X
Chlorine Trifluoride	✓	✓	-	X	-	-	S	S	✓	X	X	X	X
Cyanogen	✓	✓	-	-	-	-	-	-	-	-	-	-	-
Cyclopropane	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-	-
Deuterium	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dichlorosilane	✓	✓	-	X	-	-	✓	✓	✓	✓	-	-	-
Dimethylamine	✓	✓	X	X	X	X	✓	✓	✓	✓	X	X	-
Dimethyl Ether	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	-
Disilane	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Ethane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ethyl Chloride	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Ethylene	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Fluorine	✓	✓	S	S	S	S	S	S	S	S	X	X	X
Halocarbon-14	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Halocarbon-23	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Halocarbon-32	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Halocarbon-116	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Halocarbon-218	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Halocarbon-236a	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Halocarbon-1113	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Halocarbon-4110	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Helium	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hydrogen	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hydrogen Bromide	✓	✓	X	X	X	X	✓	✓	✓	✓	✓	X	X
Hydrogen Chloride	✓	✓	X	X	X	X	✓	✓	✓	✓	✓	X	X
Hydrogen Fluoride	✓	✓	X	X	-	X	✓	✓	✓	✓	X	X	X
Hydrogen Sulfide	✓	✓	X	✓	-	-	✓	✓	✓	✓	X	✓	✓
Isobutane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Isobutylene	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Krypton	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Methane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Methyl Bromide	✓	-	✓	X	-	✓	-	-	-	-	-	-	-
Methyl Chloride	✓	✓	✓	X	X	✓	✓	✓	✓	✓	✓	X	X
Methyl Fluoride	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	-	-	-
Methyl Mercaptan	✓	✓	✓	✓	-	✓	-	-	-	-	-	-	-
Monomethylamine	✓	X	X	X	X	X	-	-	-	-	-	-	-
Neon	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nitric Oxide	✓	✓	✓	✓	-	✓	-	-	-	-	-	-	-
Nitrogen	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nitrogen Dioxide	✓	✓	X	✓	-	X	✓	✓	-	-	X	X	X
Nitrogen Trifluoride	✓	✓	✓	-	-	✓	✓	✓	✓	✓	✓	-	-
Nitrous Oxide	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Octafluorocyclobutane	✓	✓	✓	✓	-	✓	✓	✓	✓	-	-	✓	✓
Octafluoropropane	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Oxygen	S	✓	✓	✓	✓	✓	✓	✓	✓	✓	S	X	X
Phosphine	✓	✓	-	✓	-	-	✓	✓	✓	-	-	-	-
Propane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Propylene	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	X
Silane	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Silicon Tetrachloride	✓	✓	X	X	-	X	✓	✓	✓	✓	X	X	X
Silicon Tetrafluoride	✓	✓	X	X	-	X	✓	✓	✓	✓	X	X	X
Sulfur Dioxide	✓	✓	X	✓	X	✓	✓	✓	✓	✓	✓	X	X
Sulfur Hexafluoride	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓
Sulfur Tetrafluoride	✓	✓	X	X	-	X	✓	✓	✓	✓	X	X	X
Trimethylamine	✓	✓	X	X	X	X	-	-	-	-	-	-	-
Tungsten Hexafluoride	✓	✓	X	X	-	✓	✓	✓	✓	✓	X	X	X
Vinyl Methyl Ether	✓	✓	✓	✓	-	X	-	-	-	-	-	-	-
Xenon	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 11. Regulator and tubing compatibility recommendations.

XVIII. APPENDIX VI – EMERGENCY CONTACT DETAILS

In the event of any emergency always call UTSA PD at x4911 or 210-458-4911

Other contact details are listed below. Please post this information in the laboratory near a telephone.

LABORATORY SAFETY DIVISION STAFF		
NAME	**OFFICE NUMBER**	**EMERGENCY NUMBER**
Amanda Haley	210-458-8515	210-294-3342
Natalie Metzger	210-458-6419	210-336 9509
Dianna Olukotun	210-458-5807	
Quy Fung	210-458-6697	
Cynthia Galindo	210-458-6507	

ENVIRONMENTAL HEALTH SAFETY AND RISK MANAGEMENT	
EHSRM – Main Contact Number	210-458-5250

FACILITIES	
Facilities – Facilities Service Center	210-458-4262
Facilities – Operations and Maintenance	210-458-5347

XIX. APPENDIX VII – LIST OF ABBREVIATIONS

ACGER	American Conference of Governmental Industrial Hygienists
BHT	Butylated Hydroxytoluene
BSC	Biosafety Cabinet
CAS Number	Chemical Abstract Service Number
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
CHO	Chemical Hygiene Officer
CHP	Chemical Hygiene Plan
CSC	Chemical Safety Committee
DEA	Drug Enforcement Administration
EAA	Edwards Aquifer Authority
EHSRM	Environmental Health safety and Risk Management
EPA	Environmental Protection Agency
$FeSO_4$	Ferrous Sulfate
GHS	Globally Harmonized System
H_2SO_4	Sulfuric Acid
HazCom	Hazard Communication
HAZMAT	Hazardous Material
HEPA	High-Efficiency Particulate Air
HF	Hydrofluoric Acid
HOP	Handbook of Operating Procedures
HPLC	High Performance Liquid Chromatography
IACUC	Institutional Animal Care and Use Committee
IARC	International Agency for Research on Cancer
IBC	Institutional Biosafety Committee
IRB	Institutional Review Board
ISMS	Information Security Management System
kPA	Kilo Pascal
LASAC	Laboratory Safety Advisory Committee
LC50	Medial Lethal Concentration
LD50	Median Lethal Dose
LN2	Liquid Nitrogen; N_2
LSD	Laboratory Safety Division
LSM	Laboratory Safety Manager
NFPA	National Fire Protection Association
NTP	National Toxicology Program
OSHA	Occupational Health and Safety Administration
P.I.	Principal Investigator
PEL	Permissible Exposure Limit
PFC	Peroxide Forming Chemical
PHSs	Particularly Hazardous Substances
PPE	Personal Protective Equipment
ppm	Part Per Million

RLSC	Radiation and Laser Safety Committee
SAWS	San Antonio Water System SAWS
SDS	Safety Data Sheet (former MSDS)
SOP	Standard Operation Procedure
STOT	Specific Target Organ Toxicity
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TDG	Transport of Dangerous Goods Model Regulations
TLV	Threshold Limit Values
UN Model	United Nations Model
UTSA PD	University of Texas at San Antonio Police Department
Vac/fil cycle	Evacuate-Refill cycle; the basis of all Schlenk line work
VJ	Vacuum Jacket
VP	Vice President
WCi	Workers Compensation Insurance

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16. GHS manual 7th edition
17. NFPA 55 Chapter 7(Compressed Gas Cylinders in the Workplace)
18. OSHA CFR 1910.101Subpart H (Hazardous Materials); Occupational Safety and Health Standards
19. §1910.101 Compressed gases (general requirements).
20. §1910.102 Acetylene.
21. §1910.103 Hydrogen.
22. §1910.104 Oxygen.

23. §1910.105 Nitrous oxide.