Texas State Technical College – Chemistry Department Chemical Hygiene Plan

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Texas State Technical College – Chemistry Department
Chemical Hygiene Plan

This document describes the Chemical Hygiene Plan for the Chemical Technology Department at Texas State Technical College at Waco as required by OSHA's Occupational Exposure to Hazardous Chemicals in Laboratories Standard. 29CFR1910.1450.

In order to comply with the Standard the Chemical Technology Department has established a plan to ensure our workplace is capable of protecting employees from Health Hazards associated with Hazardous Chemicals in the laboratory, and capable of keeping exposures below the Permissible Exposure Limits (PEL) specified in 29CFR1910 Subpart Z. Questions regarding this plan should be directed to Anniruddh Hathi (254-867-4859)

This plan is made readily available to the employees of the Chemical Technology Department at Texas State Technical College at Waco, employee representatives & upon request by the Assistant Secretary for the Occupational Safety & Health Administration.

A review and evaluation of this program is conducted on an annual basis and updated as necessary.

The person responsible for implementation of this plan is Anniruddh Hathi, Chemical Technology Department at Texas State Technical College at Waco. The assigned Chemical Hygiene Officer is Anniruddh Hathi .This facility has established a Chemical Hygiene Committee comprised of the following personnel:

- Aniruddh Hathi - Associate Professor, Chemistry, TSTC-Waco
- Kirk Hunter - Associate Professor, Chemistry, TSTC-Waco
- Richard Wheet - Associate Professor, Chemistry, TSTC-Waco

The CHP may be located in the Chemistry Department Office in the Technical Studies Center – Waco Texas or on the CHEMTECH.ORG website.

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1.0 PURPOSE, SCOPE, and RESPONSIBILITIES

1.1 **Purpose** The purpose of Texas State Technical College (TSTC) - Chemical Technology Department's Chemical Hygiene Plan (CHP) is to establish a written program that provides for and supports the procedures, equipment, personal protective equipment, and work practices for protecting laboratory personnel from potential health hazards of using hazardous chemicals in the laboratory.

1.2 Scope Texas State Technical College - Chemical Technology Department's CHP applies to all Texas State Technical College - Chemical Technology laboratory personnel, who handle and may be exposed to hazardous chemicals in research laboratories at TSTC.

1.3 **Exclusions** This CHP does not cover work with radioactive materials or biological agents.

1.4 Responsibilities

A. Duties Laboratory Instructor
The Laboratory Instructor has responsibility for the health and safety of laboratory personnel doing work in his/her area. The Laboratory Instructor's responsibilities include:

1 Identifying hazardous conditions or operations in the lab, determining safe procedures and controls, and implementing and enforcing standard safety procedures.
2 Establishing standard safety operating procedures (general and protocol-specific) and performing literature searches relevant to safety and health that is appropriate for the work.
3 Consulting on use of higher risk chemicals, such as Particularly Hazardous Chemicals or highly reactive chemicals or conducting higher risk experimental procedures so that special safety precautions may be taken.
4 Providing laboratory personnel under his/her supervision with access to the CHP.
5 Training laboratory personnel he/she supervises to work safely with hazardous chemicals and operations. This includes informing laboratory personnel of the location and availability of Hazard Information described in Section 10.1.
6 Maintaining in functional working order appropriate work place engineering controls (e.g., fume hoods) and safety equipment (e.g., emergency showers/eyewashes, fire extinguishers), with emphasis on controls for particularly hazardous substances.
7 Maintaining in functional working order appropriate personal protective equipment (e.g., gloves, goggles).
8 Conducting periodic laboratory inspections.
9 Prompt reporting of laboratory incidents.
10 Informing facilities personnel, other non-laboratory and any outside contractors of potential lab-related hazards when they are required to work in the laboratory environment. Identified potential hazards should be minimized to provide a safe environment for repairs and renovations.

B. Duties of All Laboratory Personnel All laboratory personnel who work with hazardous chemicals in research laboratories are responsible for:

1 Following the CHP and any individual Laboratory Safety Plan.
2 Following oral and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned.

3 Keeping the work areas safe and uncluttered.
4 Reviewing and understanding the hazards of materials and processes in their laboratory research prior to conducting work.
5 Utilizing appropriate measures to control identified hazards, including consistent and proper use of engineering controls, personal protective equipment, and administrative controls.
6 Understanding the capabilities and limitations of personal protective equipment issued to them.
7 Promptly reporting accidents and unsafe conditions to the department chairman
8 Completing all required health, safety and environmental training.

C. Duties of Chemical Department's Safety Officer (CSO) - The Chemical Department's Safety Officer is responsible for:

1 Assisting Laboratory Instructors in the selection of appropriate safety control requirements, which include laboratory practices, personal protective equipment, engineering controls, and training.
2 Performing hazards assessments, upon request.
3 Reviewing and providing advice on laboratory experiments, upon request.
4 Providing technical consultation and investigation, as appropriate, for laboratory accidents and injuries.
5 Reviewing plans for installation of engineering controls and new laboratory construction/renovation, as requested.
6 Reviewing and evaluating the effectiveness of the Chemical Hygiene Plan at least annually and updating it as appropriate.

2.0 GENERAL CLASSES OF HAZARDOUS CHEMICALS

Chemicals have inherent physical, chemical and toxicological properties that require laboratory personnel to have a good understanding of the related health and safety hazards. The main types of chemical hazards that lab personnel should be aware of are:

- Flammability
- Corrosivity
- Reactivity/ Unstability (incl. explosivity), and
- Toxicity (incl. irritation, sensitization, carcinogenicity, reproductive toxicity)

Additionally, compressed gases and cryogenic liquids are often used laboratory materials that present unique hazards.

Below is brief discussion of these major classes of hazardous chemicals.

2.1 Flammable and Combustible Liquids Flammable and combustible liquids are classified according to their flash point, with flammable liquids having a flash point of less than 100 °F and combustible liquids having a flash point between 100-200 °F. Both flammable and combustible liquids are considered fire hazards..

2.2 Corrosive Materials Corrosive materials cause destruction of tissue through chemical action at the point of contact. As corrosive chemicals can be liquids, solids, or gases, corrosive effects can affect the skin, eyes, and respiratory

tract. Examples of corrosive chemicals include: sodium hydroxide, hydrochloric acid, and phenol

2.3 Highly Reactive/ Unstable Materials Highly reactive or unstable materials are those that have the potential to vigorously polymerize, decompose, condense, or become self-reactive under conditions of shock, pressure, temperature, light, or contact with another material. Examples of highly reactive chemicals are peroxides, water-reactives, and pyrophorics.

2.4 Compressed Gases/Cryogenic Liquids and Toxic Gases Compressed gases and cryogenic liquids are similar in that they can create pressure hazards and can also create health hazardous and/ or flammable atmospheres. One special property of compressed gases and cryogenic liquids is that they undergo substantial volume expansion when released to air, potentially depleting workplace oxygen content to hazardous levels

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Toxic gases pose additional potential acute health hazards to laboratory personnel and the public, and as such, are considered TSTC "Restricted Chemicals" that require prior approval by the CSO.

2.5 OSHA "Particularly Hazardous Substances" Select carcinogens, reproductive toxins, and chemicals with high acute toxicity (also known as "highly toxic")] are considered to be high-risk materials and are treated by OSHA as "Particularly Hazardous Substances". Additional provisions for working with Particularly Hazardous Substances are described in Section 3.4.

A. Carcinogens

Carcinogens are chemicals or physical agents that cause cancer or tumor development, typically after repeated or chronic exposure. Their effects may only become evident after a long latency period and may cause no immediate harmful effects. NOTE: "Select carcinogens", as previously mentioned, also include those chemicals that are considered suspect carcinogens

B. Reproductive Toxins

Reproductive toxins include substances that cause chromosomal damage (mutations) or lethal or malformation effects on fetuses (teratogensis). Many reproductive toxins cause damage after repeated low-level exposures. Effects become evident after long latency periods.

C. Highly Toxic Chemicals

Chemicals with a high level of acute toxicity have the ability to cause harmful local and systemic effects after a single exposure. Many of these chemicals may also be characterized as a toxic gas, CDC Select Agent Toxin, corrosive, irritant or sensitizer

.

2.6 **Sensitizers** A sensitizer is a substance that causes exposed people to develop an allergic reaction in normal tissue after repeated exposure to the substance. Examples of sensitizers used in laboratories include: formaldehyde, many phenol derivatives, and latex proteins (commonly found in latex lab gloves).

2.7 **Irritants** Irritants are chemicals that cause reversible inflammatory effects on living tissue by chemical action at the site of contact. A wide variety of organic and inorganic compounds are irritants; thus, skin contact with all laboratory chemicals

should be avoided

3.0 MINIMIZING EXPOSURES TO HAZARDOUS CHEMICALS

For the general safety of laboratory personnel, all chemical usage must be conducted in adherence with the general safe laboratory practices below. The methods used to specifically control chemical exposures are categorized as follows: Engineering Controls, Administrative Controls, and Personal Protective Equipment.

3.1 **Engineering Controls:** As general lab ventilation cannot be relied upon to protect personnel from localized exposures to hazardous levels of airborne chemicals, engineering controls such as laboratory fume hoods, glove boxes and other local exhaust systems (e.g., drop down flexible ducts) are often necessary to provide additional exposure control. In general, laboratory fume hoods are recommended whenever using hazardous chemicals that:

- Have high acute toxicity, or which are carcinogens, or reproductive toxins except where there is very low risk of exposures (e.g., use of minimal quantities in a closed system).
- Have a permissible exposure limit of less than 50 ppm (or 0.25 mg/m3 for particulate matter).
- Are appreciably volatile (e.g., solvents) or are easily dispersible in air (e.g., dust).

3.2 Administrative Controls

Administrative controls for minimizing exposures to hazardous chemicals include:

- Substituting in less hazardous chemicals (e.g., using proprietary detergents instead of chromic acid for cleaning glassware; or, using toluene instead of benzene for liquid-liquid extraction or chromatography.)
- Isolating or enclosing an experiment within a closed system (i.e., glove box, sealed chamber).
- Micro scaling the size of the experiment to reduce the amount of chemical usage.

3.3 **Personal Protective Equipment** In addition to both engineering and administrative exposure controls, personal protective equipment (PPE) may be necessary to ensure an adequate margin of safety in case of incidental/ accidental chemical release or contact..

3.4. **Additional Provisions for Work Involving Particularly Hazardous Substances**

Additional provisions for laboratory work with Particularly Hazardous Substances include:

1 Establishment of a designated area;
2 Use of containment devices such as fume hoods or glove boxes;
3 Procedures for safe removal of contaminated waste; and
4 Decontamination procedures.

4.0 STANDARD OPERATING PROCEDURES (SOPs)

Laboratory Instructor is responsible for providing oral Standard Operating Procedures (SOPs) relevant to health and safety for laboratory activities he/she directs involving hazardous chemicals.

5.0 Special Precautions for Other Higher Hazard Chemicals and Operations

Laboratory personnel should consult with the CSO on following higher risk chemicals usage and operations in their laboratories so that special safety precautions can be taken, where appropriate:

- Work involving Particularly Hazardous Substances or highly reactive materials
- A procedural change that significantly increases the overall hazard of an existing procedure, such as introduction of a high hazard chemical in a procedure or scale up of an experimental procedure or operation. Careful consideration of scaled up work is critical to plan for the effects caused by an increase in chemical concentration/quantity and differences in dissolution rate and heat transfer.
- Unattended operations that represent significant likelihood of fire, explosion, or exposure to personnel if a malfunction were to occur (such as a utility outage, runaway reaction, broken container or chemical spill).
- Working alone in the laboratory.
    - Each case should be evaluated on a case-by-case basis to determine if working alone will be permitted, considering:
    - Task and hazards involved in the work;
    - Consequences resulting from a worst-case scenario;
    - The possibility of an accident or incident that would prevent the laboratory personnel from calling for help;
    - The laboratory personnel's training and experience;
    - Time the work is to be conducted.

In establishing special precautions for Particularly Hazardous Substances, consideration shall be given to the following, where appropriate:

- Establishment of a designated area Use of containment devices such as fume hoods or glove boxes
- Procedures for safe removal of contaminated waste
- Decontamination procedures

6.0 CHEMICAL EXPOSURE ASSESSMENT

Consistent adherence to general safe laboratory practices in conjunction with appropriate use of exposure controls are expected to keep laboratory chemical exposures to a safe level. Exposure risk is more likely to increase when handling hazardous chemicals outside of a lab hood, especially those chemicals:

- Having high acute toxicity or which are carcinogens or reproductive toxins except where there is very low risk of exposures (e.g., use of minimal quantities in a closed system).
- Having a permissible exposure limit of less than 50 ppm (or 0.25 mg/m3 for particulate matter).
- That are appreciably volatile or are easily dispersible in air (i.e., fine powders).
- That are used in large volumes (e.g., greater than 1 liter)

7.0 CHEMICAL LABELING, STORAGE, AND INVENTORY

Hazardous chemicals must be stored, labeled and inventoried properly to avoid confusion or mistaken identity of a chemical, to provide separation of incompatible materials, and to provide information for emergency response personnel.

7.1 Labeling and Storage

A. All Hazardous Chemicals

Hazardous chemicals must be stored and labeled properly.

B. Select Agent Toxins

In addition to the requirements detailed above, for select agent toxins (in exempt quantities), the laboratory must provide one additional layer of physical security

(i.e., toxin secured within locked freezer, or secured within a permanently fixed lock box) per the document.

C. Controlled Substances
In addition to the requirements detailed in Section A above, Controlled Substances must be stored in a securely locked, substantially constructed cabinet, located where access is limited to those individuals with controlled substances authorization.

7.2 Chemical Inventory
All hazardous chemicals must be inventoried at least once per year.

8.0 LABORATORY INSPECTIONS

Laboratory inspections are an essential function to identify and address potential health and safety deficiencies and to fulfill regulatory compliance requirements.

9.0 HAZARDOUS WASTE MANAGEMENT

Management of hazardous waste is both a critical compliance and health & safety responsibility of the lab. All laboratory personnel are required to know the following:

- The hazards of the waste chemicals in the lab
- How to properly contain and store the waste in the lab, and
- What to do in an emergency involving the lab waste.

10.0 CHEMICAL HAZARD INFORMATION AND TRAINING

To apprise laboratory personnel of the hazards of chemicals present in their work area, information and training must be made available.

10.1 **Hazard Information -**The CSO must inform laboratory personnel of the location and availability of the following information:

A. Texas State Technical College - Chemical Technology Department's Chemical Hygiene Plan.

B. Material Safety Data Sheets (MSDS)

10.2 **Work Directed by CSO** The CSO must provide laboratory personnel information and training.

A. Types of Training
Laboratory personnel must receive general and laboratory-specific training as follows:

1. **General Training**
   The CSO must provide laboratory personnel with orientation to and training on the CHP.

2. **Laboratory-Specific Training**
   Laboratory-specific training is to be provided by the CSO or his/her designee, addressing the specific chemical hazards present and emergency procedures specific to the laboratory. Also, any lab-owned equipment may require specialized training to prevent equipment damage. This can be achieved via a combination of the following:

- Review of any individual Laboratory Safety Plan.
- Review of local/ building safety information.
- Review of Standard Operating Procedure(s) involving hazardous chemicals.
- Other laboratory-specific training on particular safety procedures or hazards encountered in the laboratory environment.

11.0 EMERGENCY RESPONSE - SPILLS AND EXPOSURES

All incidents involving hazardous chemical spills and exposures require prompt action by the responders and the victims in order to control chemical exposures to personnel and to minimize impacts to the environment and property.

11.1 Emergency Response

In the laboratory, chemical-related accidents require local emergency response that may involve requesting for assistance, local clean up, and incident reporting/ follow-up.

APPENDIX

Definitions

Action level: The airborne chemical concentration that triggers air monitoring and the implementation of additional control measures. The action level is always lower than the corresponding OSHA permissible exposure limit (PEL) and is designed to protect personnel from overexposure. At TSTC, the more conservative of either the OSHA defined action level (generally one-half the PEL) or one-half the ACGIH Threshold Limit Value is used as the action level.

Carcinogen: See “Select Carcinogen”

Compressed gas:

- A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70° F (21.1°C); or
- A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130° F (54.4°C) regardless of the pressure at 70° F (21.1° C); or
- A liquid having a vapor pressure exceeding 40 psi at 100° F (37.8° C) as determined by ASTM D-323-72.

Controlled Substances: Drugs and certain other chemicals, both narcotic and nonnarcotic, which come under the jurisdiction of federal DEA and state laws regulating their manufacture, sale, distribution, use and disposal.

Corrosive: Substance causing irreversible destruction of living tissue by chemical action at the site of contact (dermal or respiratory). Major classes of corrosive substances include strong acids, strong bases, and dehydrating agents.

Cryogenic liquids: Materials with extremely low boiling points (i.e. less than – 150 °F). Common examples of cryogenic liquids are liquid nitrogen, helium, and argon. Dry ice is the common term for frozen carbon dioxide. One special property of both cryogenic liquids and dry ice is that they undergo substantial volume expansion when converted to a gas phase, which can potentially lead to an oxygen deficient atmosphere where ventilation is limited.

Explosive: A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable: A chemical that falls into one of the following categories:

- "Aerosol, flammable" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame projection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;
- (2) "Gas, flammable" means:
    - A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or
    - A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air greater than 12 percent by volume, regardless of the lower explosive limit.
- "Liquid, flammable" means any liquid having a flashpoint below 100° F (37.8° C), except any mixture having components with flashpoints of 100° F (37.8° C) or

higher, the total of which make up 99 percent or more of the total volume of the mixture.

- "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in 29 CFR 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Hazardous Chemical: A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed laboratory personnel (includes carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoitic systems, and agents which damage the lungs, skin, eyes, or mucous membranes).

Hematopoietic toxicants: Substances that decrease hemoglobin function and deprive the body tissues of oxygen (e.g. carbon monoxide, cyanides).

Hepatotoxin: Substances that produce liver damage (e.g. nitrosamines, carbon tetrachloride).

Highly Toxic: (also referred as highly acute toxin) A chemical falling within any of the following categories:

- A chemical with a median lethal dose (LD50) of 50 mg or less per Kg of body weight when administered orally to albino rats weighing between 200 and 300 gm each.
- A chemical with a median lethal dose (LD50) of 200 mg or less per Kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 Kg each.
- A chemical that has a median lethal concentration (LC50) in air of 200 ppm by volume or less of gas or vapor, or 2 mg per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 gm each.

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

Irritant: A substance, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. (dermal or respiratory). *NOTE: A wide variety of organic and inorganic compounds are irritants and consequently exposure to all laboratory chemicals should always be avoided.*

Laboratory Personnel: Includes both employee and non-employee laboratory personnel who perform teaching activities, and covers individuals employed in the laboratory workplace who may be exposed to hazardous chemicals in the course of their assignments. Employees include faculty and staff

Laboratory Safety Plan: An individual plan prepared by a laboratory instructor that covers the safety procedures pertinent to activities conducted in his/her laboratory**.**

Laboratory Instructor: The individual in charge of the laboratory.

Nephrotoxin: Substances causing damage to the kidneys (e.g. certain halogenated hydrocarbons).

Neurotoxin: Substances that produce their primary toxic effects on the nervous system (e.g. mercury, acrylamide, carbon disulfide).

Non-Laboratory personnel: Laboratory personnel such as administrative staff, plumbers, and Heating, Ventilation & Air Conditioning (HVAC) technicians entering research laboratories to perform maintenance, administrative, or other non-research laboratory tasks.

Organic peroxide: An organic compound that contains the bivalent –o-o- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizer: A chemical other than a blasting agent or explosive defined by Cal/OSHA, that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Particularly Hazardous Substances: These consist of "select carcinogens_," reproductive toxins and of acute toxicity (also defined as highly toxic).

Permissible exposure limit (PEL): The maximum permitted 8-hour time-weighted average concentration of an airborne contaminant.

Precursor Chemical: Precursor chemicals are chemicals used in the course of legitimate research that can potentially be used in the illicit production controlled substances such as methamphetamine, cocaine, heroin, and MDMA (ecstasy).

Pyrophoric: A chemical that ignite spontaneously in air at a temperature of 130 F or below**.**

Reproductive Toxin: A chemical that affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis). *IMPORTANT: Lab personnel should recognize that many chemicals have not been thoroughly assessed for their reproductive toxicity. Prior to selecting/ using chemicals in the laboratory, personnel should determine their potential reproductive toxicity risks.*

Sensitizer: A substance that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the substance. The reaction may be as mild as a rash (contact dermatitis) or as serious as anaphylactic shock**.**

Select Carcinogen: A substance or agent that meets one of the following criteria:
It is regulated by OSHA as a carcinogen.

- It is listed under the category, "known to be carcinogens" in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or
- It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer (IARC)

- It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

Unstable (reactive): A chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Water-reactive: A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with flammable materials. This general use SOP only addresses safety issues specific to flammability hazards of chemicals. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., both general use SOPs for flammable liquids and particularly hazardous substances would apply to benzene).

#2	Hazardous Chemicals/Class of Hazardous Chemicals

For the purposes of laboratory safety, both flammable and combustible liquids are considered fire hazards. Flammable liquids have a flash point of less than 100 °F and combustible liquids have a flash point of between 100-200 °F.

#3	Control of Hazards- General

- Do not heat flammable chemicals with an open flame.
- For highly flammable chemicals, avoid static electricity or hot surfaces as they can serve as ignition sources.
- Do not use electrical devices with cracked or frayed electrical wiring.
- When transferring flammable liquid from a bulk container (generally greater than five gallons), the containers must be electrically bonded and grounded.
- Transfer flammable liquids from containers of five gallon-capacity or less inside a laboratory hood (or other area with similar ventilation) to prevent accumulation of flammable concentration of vapors.

#3a	Engineering/Ventilation Controls

Flammable and combustible chemicals should be used in lab fume hoods (or other well ventilated areas) whenever possible, especially when used in larger quantities (> 500mL) or when using above room temperature and/or pressure.

#3b	Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when

entering laboratories having hazardous chemicals.

- Additionally: When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review the MSDS.

- Goggles (vs. safety glasses) are appropriate in processes where splash or spray is foreseeable.

- For hazardous chemicals that are toxic via skin contact/absorption, additional protective clothing (i.e., faceshield, apron, oversleeves) is appropriate where chemical contact with body/skin is foreseeable.

#4	Special Handling Procedures and Storage Requirements

Where greater than 10 gallons of flammables are kept, such materials must be stored within a flammable storage cabinet.

Fire extinguishers appropriate for the fire hazards present must be available in all laboratories and storage areas. Class D fire extinguishers must be available in the immediate work area when working with flammable metals such as magnesium, sodium, and potassium.

Ensure secondary containment and segregation of incompatible chemicals per guidance within the TSTC Chemical Department's CHP. Also, follow any substance-specific storage guidance provided in MSDS documentation.

#5	Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse affects to the environment. Laboratory personnel who work with hazardous chemicals are to be provided the opportunity to receive medical attention/consultation when:

- A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).

- Symptoms or signs of exposure to a hazardous chemical develop.

#6	Waste Disposal

Many flammable liquids intended for disposal may likely be considered hazardous wastes.

#7	Minimum Training Requirements

- Interpreting a MSDS
- Availability of the CHP

#8	Approval Required

Approval must be obtained from the CSO for any alteration of safety features within a laboratory.

#9	Decontamination Procedures

Personnel: If immediate medical attention is required, call x9-911. Remove any contaminated clothing, and IMMEDIATELY flush contaminated skin with water for at least 15 minutes following any skin contact. For eye exposures, IMMEDIATELY / flush eyes w/ water for at least 15 minutes.

Consult MSDS for guidance on appropriate first aid. Where medical attention is required, ensure to bring along MSDS(s) of chemical(s) to aid medical staff in proper diagnosis and treatment.

Area: Decontamination procedures vary depending on the material being handled. The toxicity of some materials can be neutralized with other reagents. All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated should be treated as a hazardous waste.

#10	Designated Area

All flammables shall be stored within a flammable cabinet

SOP for Corrosive Materials

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with corrosive materials. This general use SOP only addresses safety issues specific to corrosive hazards of chemicals. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., for perchloric acid, both the general use SOPs for corrosives and unstable reactives would apply).

#2	Hazardous Chemicals/Class of Hazardous Chemicals

Corrosive materials cause destruction of tissue through chemical action at the point of contact. As corrosive chemicals can be liquids, solids, or gases, corrosive effects can affect the skin, eyes, and respiratory tract. Examples of corrosive chemicals include: liquids such as acids and bases, bromine, and hydrogen peroxide; gases such as chlorine and ammonia; and solids such as phosphorous and phenol.

#3	Control of Hazards- General

- Handling processes should be designed to minimize the potential for splash, splatter, or other likely scenarios for accidental contact.
- Do not pour water into acid. Slowly add the acid to the water and stir.
- Never empty carboys or drums of chemicals by means of air pressure. Use a tilting rack, a safety siphon, or a liquid pump.
- Use a mechanical aid or a pipette bulb for pipetting.
- Open bottles or carboys slowly and carefully and wear protective equipment to guard hands, face, and body from splashes, vapors, gases and fumes.
- Wipe drips from containers and bench tops. Be especially careful to wipe up visible residues of sodium hydroxide and potassium hydroxide from all surfaces. Skin contact with dry residue will result in burns.

#3a	Engineering/Ventilation Controls

Use a properly functioning lab fume hood when handling strong acids/ bases, or other chemicals that can form mists/ vapors upon contact with air (often referred to as "fuming.

#3b	Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when

entering laboratories having hazardous chemicals. When handling corrosive materials, safety goggles (not safety glasses) provide the appropriate eye protection. Additionally:

- A face shield should be worn when splash or spray is foreseeable (in addition to safety glasses).
- When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review the chemical MSDS.
- Additional protective clothing (i.e., apron, oversleeves) is appropriate where chemical contact with body and/or skin is foreseeable.

#4	**Special Handling Procedures and Storage Requirements**

Ensure secondary containment and segregation of incompatible chemicals per guidance within the TSTC Chemistry Department CHP Also, follow any substance-specific storage guidance provided in MSDS documentation. Corrosives should never be stored above eye level.

#5	**Spill and Accident Procedures**

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse affects to the environment

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

- A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).
- Symptoms or signs of exposure to a hazardous chemical develop.

#6	**Waste Disposal**

Many corrosive liquids intended for disposal may likely be considered hazardous wastes.

#7	Minimum Training Requirements

- MSDS
- CHP
- Laboratory-specific training

#8	**Approval Required**

Approval must be obtained from the CSO for any alteration of safety features within a laboratory.

#9	**Decontamination Procedures**

Personnel: Remove any contaminated clothing, and IMMEDIATELY flush contaminated skin with water for at least 15 minutes following any skin contact. For eye exposures, IMMEDIATELY flush eyes with water for at least 15 minutes.

Consult MSDS for guidance on appropriate first aid. Where medical attention is required, ensure to bring along MSDS(s) of chemical(s) to aid medical staff in proper diagnosis and treatment.

All incidents involving exposure to hydrofluoric acid, phenol, or other severe skin contact hazards require immediate medical attention. Additionally seek medical attention if pain, numbness, redness, irritation or other health symptoms are apparent. Check the MSDS to see if any delayed effects should be expected.

Area: Decontamination procedures vary depending on the material being handled. The corrosivity of some materials can be neutralized with other reagents. Special neutralizing agents should be on hand to decontaminate areas.

#10	Designated Area

For corrosives that are also considered particularly hazardous substances, a designated area shall be established per the other applicable SOP(s).

SOP for Highly Reactive/Unstable Materials

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with highly reactive/unstable materials. This SOP is generic in nature and only addresses safety issues pertaining to reactivity/stability hazards of chemicals. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., for perchloric acid, both general use SOPs for highly reactive/ unstable materials and corrosives would apply).

#2	Hazardous Chemicals/Class of Hazardous Chemicals

Highly reactive or unstable materials are those that have the potential to vigorously polymerize, decompose, condense, or become self-reactive under conditions of shock, pressure, temperature, light, or contact with another material. Major types of highly reactive chemicals are explosives, peroxides, water-reactives, and pyrophorics.

#3	Control of Hazards- General

- Minimize the quantity of reactive chemicals used or synthesized to the smallest amount needed.
- Handle reactive chemicals with caution. Appropriate chemical-specific precautions must be taken for mixing even small quantities with other chemicals.
- Chemical reactions conducted at temperatures or pressures above or below ambient conditions must be performed in a manner that minimizes risk of explosion or vigorous reaction.
- Provide a mechanism for adequate temperature control and heat dissipation.
- Utilize shields and barricades, and personal protective equipment (such as face shields with throat protectors and heavy gloves) whenever there is a possibility of explosion or vigorous chemical reaction.
- Glass equipment operated under vacuum or pressure must be shielded, wrapped with tape, or otherwise protected from shattering.

#3a	Engineering/Ventilation Controls

As many reactive materials liberate combustible and/or toxic gas when exposed to water vapor or air, they should be used in a lab hood to prevent hazardous buildup of gases.

#3b	Personal Protective Equipment

- At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals.

Additionally:

- Utilize shields and barricades, and personal protective equipment (such as face shields with throat protectors and heavy gloves) whenever there is a possibility of explosion or

vigorous chemical reaction.

- When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review the MSDS.

- Goggles (not safety glasses) are appropriate for processes where splash or spray is foreseeable.

- For hazardous chemicals that are toxic via skin contact/ absorption, additional protective clothing (i.e., faceshield, apron, oversleeves) is appropriate where chemical contact with body/skin is foreseeable.

#4	Special Handling Procedures and Storage Requirements

Ensure careful handling of handling materials that may be sensitive to shock, heat, friction, or light.

Ensure secondary containment and segregation of incompatible chemicals per guidance within the TSTC Chemistry Department's CHP. Also, follow any substance-specific storage guidance provided in MSDS documentation.

#5	Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse affects to the environment

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

- A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).

- Symptoms or signs of exposure to a hazardous chemical develop.

#6	Waste Disposal

Many reactive/ unstable materials intended for disposal may likely be considered hazardous wastes.

#7	Minimum Training Requirements

- MSDS
- CHP
- Laboratory-specific training

#8	Approval Required

Approval must be obtained from the CSO for any alteration of safety features within a laboratory.

#9	Decontamination Procedures

Personnel: Remove any contaminated clothing, and IMMEDIATELY flush contaminated skin with water for at least 15 minutes following any skin contact. For eye exposures, IMMEDIATELY flush eyes with water for at least 15 minutes.

Consult MSDS for guidance on appropriate first aid. Where medical attention is required, ensure to bring along MSDS(s) of chemical(s) to aid medical staff in proper diagnosis and treatment.

Area: Decontamination procedures vary depending on the material being handled. The toxicity of some materials can be neutralized with other reagents. All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated should be treated as a hazardous waste.

#10	Designated Area

For highly reactive/unstable materials that are also considered particularly hazardous substances, a designated area shall be established.

SOP for Compressed Gases

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with compressed gases. This general use SOP only addresses safety issues specific to compressed gases. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., for flammable gases, both this general use SOP and the general use SOP for flammables would apply).

#2	Hazardous Chemicals/Class of Hazardous Chemicals

Compressed gases have inherent pressure hazards and can also create health hazardous and/ or flammable atmospheres. Common hazard characteristics of gases include flammability, toxicity, and corrosivity. A few gases (i.e., silane, diborane, phosphine) are considered pyrophoric (will ignite spontaneously in air).

One additional hazard property common to all compressed gases is the substantial volume expansion when released to air. Gas release in an inadequately ventilated room can create an oxygen-deficient environment.

#3	Control of Hazards- General

- Check connections and hoses regularly for leaks using a specific monitoring instrument or soapy water (or equivalent).
- When using highly flammable or toxic gas, check the delivery system using an inert gas prior to introducing the hazardous gas.
- When using compressed acetylene: (i) do not exceed a working pressure of 15 psig, and (ii) do not use vessels, piping, or other materials that contain a significant amount of copper (usually considered to be more than 50% copper).
- Replace valve caps when cylinders are not in use or before moving.
- Remove damaged or defective cylinders from service (contact the cylinder vendor for assistance).

#3a	Engineering/Ventilation Controls

If the process does not permit gas use and/or storage in well-ventilated areas (i.e., lab ventilation having a minimum of 6 air changes per hour), contact the CSO.

#3b	Personal Protective Equipment

At minimum, lab coats, safety glasses, and closed toed shoes should be worn when handling compressed gases. Depending on the hazard characteristics, additional protective equipment may be necessary.

#4	Special Handling Procedures and Storage Requirements

Safe Handling:

- Compressed gas cylinders must be transported using hand-trucks or other appropriate means. **NEVER TRANSPORT UNSECURED COMPRESSED GAS CYLINDERS!**
- Cylinders should be transported upright whenever possible (always transport acetylene in an upright (vertical) position).
- Elevators can be a confined space – NEVER ride in an elevator with compressed gas cylinders. Have one person send the elevator and another person receives the elevator.

Safe Storage:

- Secure compressed gas cylinders (>26" tall) to an anchored rack using two metal chains (at 1/3 and 2/3 cylinder height).
- No more than two cylinders may be secured with one pair of chains.
- Segregate and clearly mark full and empty ("MT") cylinders.
- Store compressed gas cylinders away from heat sources, and flammable and highly combustible materials (such as oil and greases).
- Segregate according to hazard class and chemical compatibility. Ensure to separate flammable and oxidizing gases.
- Store flammable gases away from flammable solvents, combustible material, ignition sources (including unprotected electrical connections), and oxygen gas cylinders and liquid oxygen (at least 20 feet if possible).

Additionally, follow all substance-specific storage guidance provided in MSDS documentation.

#5	Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse affects to the environment, refer to the MSDS.

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

- A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).
- Symptoms or signs of exposure to a hazardous chemical develop.

#6	Waste Disposal

Coordinate with vendor for return of cylinders.

#7	Minimum Training Requirements

- MSDS

- CHP
- Laboratory-specific training

#8	Approval Required

Approval must be obtained from the CSO for any alteration of safety features within a laboratory.

#9	Decontamination Procedures

Not applicable

#10	Designated Area

For compressed gases that are also considered particularly hazardous substances, a designated area shall be established.

SOP for Cryogenic Liquids

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with cryogenic liquids and dry ice. This general use SOP only addresses safety issues specific to cryogenic hazards of chemicals. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., for liquid hydrogen, both this general use SOP and the general use SOP for flammable liquids would apply

#2	Hazardous Chemicals/Class of Hazardous Chemicals

Cryogenic liquids are materials with extremely low boiling points (i.e. less than – 150 °F). Common examples of cryogenic liquids are liquid nitrogen, helium, and argon. Dry ice is the common term for frozen carbon dioxide. One special property of both cryogenic liquids and dry ice is that they undergo substantial volume expansion when converted to a gas phase, which can potentially lead to an oxygen deficient atmosphere where ventilation is limited. Few cryogenic liquids can also pose additional hazards including toxicity and flammability (i.e. liquid carbon monoxide).

#3	Control of Hazards- General

- Only work with cryogenic liquids in well-ventilated areas to avoid localized oxygen depletion or build up of flammable or toxic gas.
- Handle objects that are in contact with cryogenic liquids with tongs or proper gloves.
- Transfers or pouring of cryogenic liquids should be done carefully to avoid splashing.
- Containers and systems containing cryogenic liquids should have pressure relief mechanisms.
- Cryogenic liquid cylinders and other containers (such as Dewar flasks) should be filled no more than 80% of capacity to protect against thermal expansion.
- Cryogenic liquid/dry ice baths should be open to the atmosphere to avoid pressure build up.
- Keep liquid oxygen away from organic materials and ignition sources.
- Transfer of liquid hydrogen in an air atmosphere can condense oxygen in the liquid hydrogen, creating an explosion risk.
- Cryotube thawing - In addition to wearing proper safety equipment, when thawing cryotubes, place the cryotube in a heavy-walled container (e.g., a desiccator) or behind a safety shield to protect yourself in the event that the tube shatters.
- Shield or wrap fiber tape around glass dewars to minimize flying glass and fragments should an explosion occur. Note: Plastic mesh will not stop small glass fragments.

#3a	Engineering/Ventilation Controls

If the process does not permit the handing of cryogenic liquids in well-ventilated areas (i.e., lab ventilation having a minimum of 6 air changes per hour), contact the CSO.

#3b	Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals. Additionally when handling cryogenic liquids, heavy gloves (e.g., cryogenic gloves), safety goggles, face shield, and lab apron are appropriate.

#4 Special Handling Procedures and Storage Requirements

Cryogenic liquid dewars are to be stored in well-ventilated areas. Storage in unventilated closets, environmental rooms, and stairwells is prohibited.

Large dewars must be tethered/ anchored to a wall.

Store flammable cryogenic liquids and liquid oxygen away from combustible materials and sources of ignition.

Additionally, follow all substance-specific storage guidance provided in MSDS documentation.

#5 Spill and Accident Procedures

Do not attempt to clean up any spill of cryogenic liquid. If a large spill or dewar leak occurs, immediately exit the area . Laboratory personnel who work with hazardous chemicals are to be provided the opportunity to receive medical attention/consultation when:

- A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).
- Symptoms or signs of exposure to a hazardous chemical develop.

#6 Waste Disposal

Coordinate w/ vendor for return of dewar(s).

#7 Minimum Training Requirements

- MSDS
- CHP
- Laboratory-specific training

#8 Approval Required

Approval must be obtained from the CSO for any alteration of safety features within a laboratory.

#9 Decontamination Procedures

Personnel: If skin or eye(s) comes in contact with a cryogenic liquid, run the area of skin under cool or warm water for fifteen minutes (do not use hot or cold water). DO NOT RUB OR MASSAGE AFFECTED AREAS— this can cause further tissue damage. Refer to MSDS for any specific instructions. Where medical attention is required, ensure to bring along MSDS(s) of

chemical(s) to aid medical staff in proper diagnosis and treatment.

#10	Designated Area

For cryogens that are also considered particularly hazardous substances, a designated area shall be established.

SOP for Carcinogens

#1 Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with carcinogenic materials. This general use SOP only addresses safety issues specific to carcinogenic hazards of chemicals. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., for benzene, both general use SOPs for flammables and carcinogens would apply.

#2 Hazardous Chemicals/Class of Hazardous Chemicals

A carcinogen (defined as "select carcinogen" by OSHA) is a substance or agent that meets one of the following criteria:

1. It is regulated by OSHA as a carcinogen.
2. It is listed under the category, "known to be carcinogens" in the Annual Report on Carcinogens published by the **National Toxicology Program** (NTP)(latest edition); or
3. It is listed under Group 1 ("carcinogenic to humans") by the **International Agency for Research on Cancer** (IARC)
4. It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:
    a. (a) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3;
    b. (b) After repeated skin application of less than 300 mg/kg of body weight per week; or
    c. (c) After oral dosages of less than 50 mg/kg of body weight per day.

#3 Control of Hazards - General

Although the specific SOPs will vary according to the material used, the following guidelines are generally applicable for projects involving carcinogens:

1. Use the smallest amount of chemical that is consistent with the requirements of the work to be performed.
2. Use containment devices (such as lab fume hoods or glove boxes) when: (i) volatilizing these substances, (ii) manipulating substances that may generate aerosols, and (iii) performing laboratory procedures that may result in

uncontrolled release of the substance.

3. Use high efficiency particulate air (HEPA) filters, carbon filters, or scrubber systems with containment devices to protect effluent and vacuum lines, pumps, and the environment whenever feasible.

4. Use ventilated containment to weigh out solid chemicals. Alternatively, the tare method can be used to prevent inhalation of the chemical. While working in a laboratory hood, the chemical is added to a pre-weighed container. The container is then sealed and can be re-weighed outside of the hood. If chemical needs to be added or removed, this manipulation is carried out in the hood. In this manner, all open chemical handling is conducted in the laboratory hood.

#3a	Engineering/Ventilation Controls

Use a properly functioning lab fume hood when handling carcinogens.

If the process does not permit the handing of such materials in a fume hood, contact the CSO.

#3b	Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals. Additionally:

- When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review the MSDS.

- Goggles (not safety glasses) are appropriate for processes where splash or spray is foreseeable.

- For hazardous chemicals that are toxic via skin contact/ absorption, additional protective clothing (i.e., face shield, apron, oversleeves) is appropriate where chemical contact w/ body/skin is foreseeable.

#4	Special Handling Procedures and Storage Requirements

Ensure secondary containment and segregation of incompatible chemicals per guidance within the TSTCS Chemistry Department CHP. Also, follow any substance-specific storage guidance provided in MSDS documentation.

#5	Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse affects to the environment.

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

- A spill, leak, explosion or other occurrence results in a hazardous exposure (potential

overexposure).

- Symptoms or signs of exposure to a hazardous chemical develop.

#6	Waste Disposal

Carcinogens intended for disposal are considered hazardous wastes.

#7	Minimum Training Requirements

- MSDS
- CHP
- Laboratory-specific training

#8	Approval Required

Approval must be obtained from the CSO for any alteration of safety features within a laboratory.

#9	Decontamination Procedures

Personnel: Immediately after working with carcinogens, remove gloves, wash hands and arms with soap and water.

Area: Decontamination procedures vary depending on the material being handled; consult the MSDS. The toxicity of some materials can be neutralized with other reagents. All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated should be treated as a hazardous waste.

Equipment: Decontaminate vacuum pumps or other contaminated equipment (glassware) before removing them from the designated area.

#10	Designated Area

For use of carcinogens, a designated area shall be established where limited access, special procedures, knowledge, and work skills are required. A designated area can be the entire laboratory, a specific laboratory workbench, or a laboratory hood. Designated areas must be clearly marked with signs that identify the chemical hazard and include an appropriate warning; for example: WARNING! FORMALDEHYDE WORK AREA – CARCINOGEN.

- Upon leaving the designated area, remove any personal protective equipment worn and wash hands, forearms, face, and neck.

- After each use (or day), wipe down the immediate work area and equipment to prevent accumulation of chemical residue.

- At the end of each project, thoroughly decontaminate the designated area before resuming normal laboratory work in the area.

SOP for Highly Acutely Toxic Materials

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with materials having high acute toxicity, also referred to as highly toxic materials. This SOP is generic in nature and only addresses safety issues specific to the high acute toxicity of chemicals. In some instances, several general use SOPs may be applicable for a specific chemical (i.e., for carbon monoxide gas, general use SOPs for highly toxics, flammables, and compressed gases could apply).

#2	Hazardous Chemicals/Class of Hazardous Chemicals

A highly toxic material is considered a chemical falling within any of the following categories:

1. A chemical with a median lethal dose (LD50) of 50 mg or less per Kg of body weight when administered orally to albino rats weighing between 200 and 300 gm each.

2. A chemical with a median lethal dose (LD50) of 200 mg or less per Kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 Kg each.

3. A chemical that has a median lethal concentration (LC50) in air of 5000 ppm by volume or less of gas or vapor, or 50 mg per liter or less of mist, fume, or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 gm each.

#3	Control of Hazards- General

Although the specific SOPs will vary according to the material used, the following guidelines are generally applicable for projects involving highly toxic materials:

1. Use the smallest amount of chemical that is consistent with the requirements of the work to be performed.

2. Use containment devices (such as lab fume hoods or glove boxes) when: (i) volatilizing these substances, (ii) manipulating substances that may generate aerosols, and (iii) performing laboratory procedures that may result in uncontrolled release of the substance.

3. Use high efficiency particulate air (HEPA) filters, carbon filters, or scrubber systems with containment devices to protect effluent and vacuum lines, pumps, and the environment whenever feasible.

4. Use ventilated containment to weigh out solid chemicals. Alternatively, the tare method can be used to prevent inhalation of the chemical. While working in a

laboratory hood, the chemical is added to a pre-weighed container. The container is then sealed and can be re-weighed outside of the hood. If chemical needs to be added or removed, this manipulation is carried out in the hood. In this manner, all open chemical handling is conducted in the laboratory hood.

#3a	Engineering/Ventilation Controls

Use a properly functioning lab fume hood when handling highly toxic materials.
If the process does not permit the handing of such materials in a fume hood, contact the CSO.

#3b	Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals

Additionally:

- When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review the chemical MSDS.
- Goggles (not safety glasses) are appropriate for processes where splash or spray is foreseeable.
- For hazardous chemicals that are toxic via skin contact/ absorption, additional protective clothing (i.e., faceshield, apron, oversleeves) is appropriate where chemical contact w/ body/ skin is foreseeable.

#4	Special Handling Procedures and Storage Requirements

Ensure secondary containment and segregation of incompatible chemicals per guidance within the TSTC Chemistry Department's CHP. Also, follow any substance-specific storage guidance provided in MSDS documentation.

#5	Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse affects to the environment.

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

- A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).
- Symptoms or signs of exposure to a hazardous chemical develop.

#6	Waste Disposal

Highly toxic materials intended for disposal are considered hazardous wastes.

#7 Minimum Training Requirements

- MSDS
- CHP
- Laboratory-specific training

#8 Approval Required

Approval must be obtained from the CSO for any alteration of safety features within a laboratory.

#9 Decontamination Procedures

Personnel: Immediately after working with highly acutely toxic materials, remove gloves and wash hands and arms with soap and water.

Area: Decontamination procedures vary depending on the material being handled. The toxicity of some materials can be neutralized with other reagents. All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated should be treated as a hazardous waste.

Equipment: Decontaminate vacuum pumps or other contaminated equipment (glassware) before removing them from the designated area.

#10 Designated Area

For use of highly toxic materials, a designated area shall be established where limited access, special procedures, knowledge, and work skills are required. A designated area can be the entire laboratory, a specific laboratory workbench, or a laboratory hood. Designated areas must be clearly marked with signs that identify the chemical hazard and include an appropriate warning; for example: WARNING! HYDROFLUORIC ACID WORK AREA – HIGHLY TOXIC MATERIAL.

- Upon leaving the designated area, remove any personal protective equipment worn and wash hands, forearms, face, and neck.
- After each use (or day), wipe down the immediate work area and equipment to prevent accumulation of chemical residue.
- At the end of each project, thoroughly decontaminate the designated area before resuming normal laboratory work in the area.

SOP for Sensitizers

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with sensitizers. As sensitizers often have other potential hazard characteristics such as carcinogenicity and corrosivity, ensure to account for these risks also

#2	Hazardous Chemicals/Class of Hazardous Chemicals

A sensitizer (allergen) is a substance that causes exposed people to develop an allergic reaction in normal tissue after repeated exposure to the substance. Examples of compounds that may cause sensitization in some individuals are diazomethane, various isocyanates, formaldehyde, and benzylic and allylic halides.

#3	Control of Hazards- General

Handling processes should be designed to minimize the potential for splash, splatter, or other likely scenarios for accidental contact.

#3a	Engineering/Ventilation Controls

Use a properly functioning lab fume hood when handling sensitizers that can be inhaled (via mist/fume/gas/vapor).

#3b	Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals.

Additionally:

- When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review the chemical MSDS.
- Goggles (not safety glasses) are appropriate for processes where splash or spray is foreseeable.
- For hazardous chemicals that are toxic via skin contact/ absorption, additional protective clothing (i.e., faceshield, apron, oversleeves) is appropriate where chemical contact with body/skin is foreseeable.

#4	Special Handling Procedures and Storage Requirements

Ensure secondary containment and segregation of incompatible chemicals per guidance within the TSTC Chemistry Department's CHP. Also, follow any substance-specific storage guidance

provided in MSDS documentation.

#5	Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse affects to the environment.

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

- A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).
- Symptoms or signs of exposure to a hazardous chemical develop.

#6	Waste Disposal

Many sensitizers intended for disposal may likely be considered hazardous wastes

#7	Minimum Training Requirements

- MSDS
- CHP
- Laboratory-specific training

#8	Approval Required

Approval must be obtained from the CSO for any alteration of safety features within a laboratory.

#9	Decontamination Procedures

Personnel: Remove any contaminated clothing, and IMMEDIATELY flush contaminated skin with water for at least 15 minutes following any skin contact. For eye exposures, IMMEDIATELY flush eyes w/ water for at least 15 minutes.

Consult MSDS for guidance on appropriate first aid. Where medical attention is required, ensure to bring along MSDS(s) of chemical(s) to aid medical staff in proper diagnosis and treatment.

Area: Carefully clean work area after use. Decontamination procedures vary depending on the material being handled.

#10	Designated Area

For sensitizers that are also considered particularly hazardous substances, a designated area shall be established.

SOP for Irritants

#1	Process or Experiment Description

This standard operating procedure (SOP) is intended to provide general guidance on how to safely work with irritants. As irritation is only a secondary health effect with many substances, ensure to account for other more significant hazards such as carcinogenicity and corrosivity

#2	Hazardous Chemicals/Class of Hazardous Chemicals

Irritants are chemicals that cause reversible inflammatory effects on living tissue by chemical action at the site of contact. A wide variety of organic and inorganic compounds are irritants; thus, skin contact with all laboratory chemicals should be avoided.

#3	Control of Hazards- General

Handling processes should be designed to minimize the potential for splash, splatter, or other likely scenarios for accidental contact.

#3a	Engineering/Ventilation Controls

Use a properly functioning lab fume hood when handling sensitizers that can be inhaled (via mist/fume/gas/vapor).

#3b	Personal Protective Equipment

At minimum, safety glasses, lab coat, long pants, and closed toed shoes are to be worn when entering laboratories having hazardous chemicals.

Additionally:

- When handling hazardous chemicals or contacting potentially contaminated surfaces, protective gloves are to be worn. For proper selection of glove material, review the chemical MSDS.
- Goggles (not safety glasses) are appropriate for processes where splash or spray is foreseeable.
- For hazardous chemicals that are toxic via skin contact/ absorption, additional protective clothing (i.e., faceshield, apron, oversleeves) is appropriate where chemical contact with body/skin is foreseeable.

#4	Special Handling Procedures and Storage Requirements

Ensure secondary containment and segregation of incompatible chemicals per guidance within

the TSTC Chemistry Department's CHP. Also, follow any substance-specific storage guidance provided in MSDS documentation.

#5	Spill and Accident Procedures

Prompt response to chemical spills is critical to protect worker health & safety and to mitigate adverse affects to the environment.

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

- A spill, leak, explosion or other occurrence results in a hazardous exposure (potential overexposure).
- Symptoms or signs of exposure to a hazardous chemical develop.

#6	Waste Disposal

Irritant substances intended for disposal may likely be considered hazardous wastes

#7	Minimum Training Requirements

- MSDS
- CHP
- Laboratory-specific training

#8	Approval Required

Approval must be obtained from the CSO for any alteration of safety features within a laboratory.

#9	Decontamination Procedures

Personnel: If immediate medical attention is required, call x9-911.

Remove any contaminated clothing, and IMMEDIATELY flush contaminated skin with water for at least 15 minutes following any skin contact. For eye exposures, IMMEDIATELY flush eyes w/ water for at least 15 minutes.

Consult MSDS for guidance on appropriate first aid. Where medical attention is required, ensure to bring along MSDS(s) of chemical(s) to aid medical staff in proper diagnosis and treatment.

Area: Carefully clean work area after use. Decontamination procedures vary depending on the material being handled.

#10	Designated Area

For irritants that are also considered particularly hazardous substances, a designated area shall

be established.

Selecting Personal Protective Equipment

Summary: Personal protective equipment (PPE) is a necessary part of laboratory safety in addition to engineering controls (i.e., laboratory ventilation and laser interlocks) and good work practices. When properly selected and used, personal protective equipment can be effective in minimizing individual exposure. Always inspect personal protective equipment prior to use, and if found to be defective, replace gear as appropriate.

What to do?	How to do this?
Determine type of PPE to use.	Review SOP, MSDS and other hazard information to determine appropriate PPE to wear based on chemical hazards encountered.
Safety eyewear use and selection	At minimum, safety glasses are required for all persons entering areas where chemicals are stored or used. 1. Safety glasses must have side shields and meet ANSI Z87.1 standards. Prescription glasses are not considered a form of eye protection. 2. Contact lenses may be worn if appropriate protective eyewear is also worn. Contact lenses ARE NOT considered a form of eye protection. 3. ANSI Z87.1 chemical goggles must be worn during chemical transfer/ handling operations or during any other operations having any likelihood for chemical splash or spray (i.e., processes above or below ambient pressure) may occur. 4. In addition to safety eyewear, an ANSI Z87.1 face shield is to be worn when working with highly corrosive chemicals, where there is any likelihood for chemical splash/spray, or where flying fragments/particles are generated. 5. For procuring prescription ANSI Z87.1 protective eyewear.
Glove use and selection	**Selection:** 1. No single material can protect against all chemical, physical (e.g., cuts, abrasions, burns temperature extremes) or biological hazards. It is critical to select the correct glove for the hazard. 2. Incorrect selection results in false sense of security and increased exposure. **Inspections:** 1. Inspect gloves before and after each use. 2. Check for perforations by inflating gloves with air or

	water. 3. Inspect visually for tears or rips. 4. Discoloration or stiffness may indicate chemical degradation. 5. Torn or damaged gloves should be replaced immediately. **Use:** 1. For disposable gloves, replace when chemical contact occurs, or when damage is suspected. 2. Wash hands after removing gloves (even when double gloving). 3. Remove gloves before you leave the lab or handling objects such as doorknobs, telephones, or computer keyboards. 4. Use designated pens when wearing gloves. **Cleaning and Storage:** 1. For reusable gloves, wash after removal and air dry in lab. 2. Store gloves in clean area away from chemicals, temperature extremes, and other hazards. **Disposal:** 1. Dispose of contaminated gloves in the proper hazardous waste container.
Skin/body protection	**Laboratory coats** 1. Lab coats should be worn in laboratories where chemicals are used and/ or stored. Laboratory coats must be removed immediately upon discovery of significant contamination. 2. Personal apparel: Wear long pants and shoes that completely cover the feet (having no or low heels). Loose clothing and long hair must be restrained. **Specific chemical protective clothing**

	1. Wear appropriate chemical-protective clothing (i.e., aprons, oversleeves) when chemical contact to the body is anticipated or when extremely toxic or corrosive chemicals are handled (e.g., hydrofluoric acid).
Respiratory protection	1. Respiratory protection is not usually required during laboratory operations where work can be performed in a laboratory fume hood. 2. When it is not feasible to conduct operations within a fume hood, contact the CSO. 3. If respirator use is required, users must receive a medical evaluation, be fitted, and trained for respirator use prior to using respiratory protection.
Hearing protection	1. Hearing protection is rarely required during laboratory operations. 2. If a laboratory operation generates noise conditions in which researchers have to raise their voices to be heard, contact the CSO. 3. Hearing protectors such as earmuffs or earplugs may be necessary to minimize noise exposures.

Chemical Waste Disposal

Summary: Hazardous waste is defined as a waste, or combination of wastes, which because of its quantity, concentration, or physical or chemical characteristics may pose a substantial present or potential threat to human health or the environment when improperly treated, stored, disposed of, transported, or otherwise managed.

What to do?	Resource
Follow the General Waste Management Practices:	1. All faculty, students, and staff who generate hazardous waste must comply with appropriate waste disposal methods. 2. All lab wastes containing chemical constituents are presumed to be regulated hazardous wastes. 3. Reagent containers that are in good condition and have a readable original manufacturer's label are considered surplus chemicals. 4. Do not dispose of hazardous chemicals or solutions containing hazardous chemicals in any sink or floor drain. Aqueous solutions containing only acids or bases and no toxic metals may be drain disposed due to the lime pit. 5. Do not dispose of any hazardous materials in the solid waste containers (trash cans, dumpsters), which go to the landfill. 6. Chemical waste must be under the "control" of the person generating the waste at all times and must not be stored in general traffic locations such as halls or other areas with general public access. ▪ Common areas may be used for collection of laboratory hazardous waste under the following restrictions. ▪ maintenance or other non-lab waste may be accumulated. ▪ No more than 55 gallons may be accumulated. ▪ The area must be as close as practical to the waste generating locations.
Segregate Waste as follows:	1. Segregate incompatible wastes from each other utilizing separate storage provisions such as individual secondary containers.

	2. Do not mix incompatible wastes in a waste container.
Accumulate Waste as follows:	No waste containers may accumulate in the lab for longer than 12 months. Waste containers must be chemically compatible with the waste. Keep containers tightly closed at all times except when transferring waste. If using a funnel, the funnel must be removed and a tight fitting lid affixed as soon as you have completed the addition of waste. All wastes must be secondarily contained while in storage.
Label Waste as follows:	1. Waste containers must be labeled when waste begins to be collected, e.g.; as soon as the first drop of waste is put in the container, not when the container becomes full. • Reaction residues become wastes as soon as they are removed from the experimental equipment. • Samples and working solutions become wastes when they are no longer needed. Lab personnel make this determination.

Health Threatening Emergencies
(Fire Explosion, Serious Injury, or other Immediate Danger)

In the event of an imminent or actual health-threatening emergency (threatening local or public health, safety, or welfare; or the environment outside the immediate area):

1. **CALL 9-911 for the Fire Department.**
2. **Alert people in the vicinity, activate local alarm systems.**
3. **Evacuate the area.**
4. **REMAIN NEARBY TO ADVISE EMERGENCY RESPONDERS.**

If Personnel Exposed:

2. Remove exposed/contaminated individual(s) from area, unless unsafe to do so because of

    a. medical condition of victim(s), or

    b. potential hazard to rescuer(s).

3. In all instances, immediately call 9-911 if immediate medical attention is required.

4. Contact the CSO to report the potential exposure.

5. Administer First Aid as appropriate.

6. Flush contamination from eyes/skin using the nearest emergency eyewash /shower for a minimum of 15 minutes. Remove any contaminated clothing.

7. **Take copy of MSDS(s) of chemical(s) to hospital with victim.**

Small Spills, Local Clean-up

In the event of a minor spill or release that can be cleaned up by local personnel using readily available equipment (absorbent and small spill kits):

1. Notify personnel in the area and restrict access. Eliminate all sources of ignition.

2. Review the MSDS for the spilled material, or use your knowledge of the hazards of the material to determine the appropriate level of protection.

3. Wear gloves and protective eyewear. Clean up using absorbent. Put the contaminated absorbent in a labeled hazardous waste container.

Lab Safety Basics

Summary: Below are general safe laboratory practices for personnel working in laboratories where hazardous chemicals are used and/or stored.

1. **Understanding Hazards:**

   - KNOW THE HAZARDS OF THE CHEMICALS YOU ARE WORKING WITH! Consult the Material Safety Data Sheet (MSDS) or other appropriate references prior to using a chemical with which you are unfamiliar.

   - Assume that unknown materials are toxic, and that a mixture is more toxic than its most toxic compound.

   - Minimize exposure to all chemicals regardless of toxicity or their familiarity. Most laboratory chemicals have not been fully characterized with respect to their toxicity; as such, it is prudent to implement procedures that will minimize the likelihood of exposure. Skin contact should always be avoided. Avoid inhalation of chemicals; never "sniff" to test chemicals.

2. **Emergencies:** Know the location and proper use of emergency equipment, such as safety showers, fire extinguishers, and fire alarms.

3. **Engineering Controls:** Minimize chemical exposure through consistent and proper use of fume hoods, glove boxes or other ventilated enclosures.

4. **Personal Protective Equipment:** Wear appropriate personal protective equipment at all times.

   a. At minimum, wear safety glasses, laboratory coat, long pants and closed-toed shoes for entering a laboratory where chemicals are in use.

   b. Remove gloves when leaving the laboratory, so as not to contaminate doorknobs, etc.

5. **Working Alone and Unattended Operations:**

   a. Consult with your Principal Investigator if planning to work alone or running an unattended operation.

   b. Communicate with others in the building when working alone in the laboratory; let them know when you arrive and leave. Avoid working alone in the laboratory when performing high-risk operations.

   c. Use cautious judgment when leaving unattended operations: i) Post signs to communicate appropriate warnings and precautions, ii) Anticipate potential equipment and facility failures, and iii) Provide containment for release of hazardous chemicals.

6. **Avoid Ingesting Chemicals:**

   Do:

   - Wash your hands frequently to minimize chemical exposure through ingestion and direct contact with the skin.
   - Always wash hands before eating, drinking, smoking, or applying cosmetics.

   Don't:

   - Use mouth suction for pipetting or siphoning.
   - Consume or store food/beverages or apply cosmetics in laboratories (including refrigerators and cold rooms) or chemical storage areas.

7. **Labeling:** Label all chemical containers with the identity of the contents (avoid abbreviations/ acronyms); hazard warning and chemical concentration information should also be included.
8. **Transporting:** Use appropriate safety carriers (secondary containment) when transporting chemicals either inside or outside of the building.
9. **Lab Cleanliness:** Keep work area clean and uncluttered; clean up work area on completion of an operation or at the end of the day.
10. **Cold/Warm Rooms:** As most controlled temperature rooms (i.e., cold/ warm rooms) lack mechanical exhaust (100% recirculated air), storage and use of toxic substances, flammable solvents, corrosive acids, asphyxiants (such as nitrogen and carbon dioxide), and open flames (e.g. Bunsen burners) are strictly prohibited.