CHEMICAL LABORATORY SAFETY

AND

HAZARD COMMUNICATION

COMPLIANCE MANUAL

Texas A&M University

Building: Integrated Ocean Drilling Program **Unit or Dept:** Science Services **Rooms:** B102, B113, B114

Principle Investigator: Dr. Jeff Fox **Phone / E-mail** fox@iodp.tamu.edu

Supervisor-in-Charge: Dr. Tom Davies **Phone / E-mail** davies@iodp.tamu.edu

Environmental Health and Safety Department
March, 2002 (Revised: March 2004)

EMERGENCY ASSISTANCE -- Fire, Ambulance, Police
From On-Campus Phone ---9-911
From Off-Campus Phone --- 911

Non-Emergency Assistance	From On-Campus Phone	From Off-Campus Phone
College Station		
Fire	9-764-3700	764-3700
Police	9-764-3600	764-3600
Ambulance	9-764-3700	764-3700
Bryan		
Fire	9-361-3888	361-3888
Police	9-361-3888	361-3888
Ambulance	9-764-3700	764-3700
Brazos County (Rural)		
Fire	9-361-3888	361-3888
Sheriff	9-361-4100	361-4100
University Police	5-2345	845-2345
Dept. of Public Safety (State Troopers)	9-776-3101	776-3101
FBI	9-822-6916	822-6916
Crime Stoppers	9-775-8477	775-8477
Hospital		
St. Joseph	9-776-3777	776-3777
College Station Medical Center	9-764-5100	764-5100
Scott & White Urgent Care	9-691-3648	691-3648
TAMU Environmental Health & Safety		
General Information & Assistance	5-2132	845-2132
Spill Response	5-2132	845-2132
Radiological	5-2132	845-2132
Maintenance Service (Non-business hours)	5-1361 5-4311	845-1361 845-4311

UNIVERSITY COMMITMENT TO SAFETY AND HEALTH

Texas A&M University is committed to providing its employees, students and visitors a safe environment in which to work, study and play. Safety is the business and responsibility of every campus citizen and can be better achieved through proper engineering, education, training, protective equipment, and enforcement of safety rules. Each student and employee is responsible for understanding and practicing appropriate safety procedures for his or her own protection and to protect others.

All Deans, Directors, Department Heads, Chairpersons, and Supervisors must take an active role in the University's safety program by initiating preventive measures to control hazards associated with activities under their direction.....

Dr. Ray M. Bowen
President, Texas A&M University

FOREWORD

This Manual is intended to provide structure and guidance for research laboratories in complying with the Texas Hazard Communication Act (THCA) and the TAMU Hazard Communication Program (TAMU HazCom).

The TAMU HazCom Program describes how TAMU complies with the THCA.

Research laboratories may be exempted from certain labeling, inventory and reporting requirements (see below).

IMPORTANT DEFINITIONS

- **"Act"** refers to the Texas Hazard Communication Act (THCA)
- **Employee:** A person (including students) who is on the payroll of TAMU or a TAMUS Agency and who may, or may have been exposed to hazardous chemicals in the workplace under ***normal*** working conditions or ***foreseeable*** emergency. Employees (e.g. secretaries, office workers) whose employment does not include routine exposure to hazardous chemicals are not covered by the Texas Hazard Communication Act (THCA). THCA regulations also do not apply to students who are not employed by TAMU or a TAMUS Agency.
- **Precursor Chemicals:** The Texas Higher Education Coordinating Board and the Texas Department of Public Safety developed a Memorandum of Understanding intended to prevent diversion of equipment and chemicals from academic labs to the production of illicit drugs. The specific precursor compounds are in Appendix B.
- The **TAMU Hazard Communication (HazCom) Program** describes the procedures whereby the University complies with the Act.
- **Research Laboratory**: A laboratory that engages in only research or quality control operations. Chemical specialty product manufacturing laboratories, full scale pilot plant operation laboratories that produces products for sale, and service laboratories are not research laboratories. *Chemical storerooms (unless accessible only through a research laboratory) and teaching labs are NOT research laboratories.*
  NOTE: Academic research laboratories are exempted from some of the requirements of the Texas Hazard Communication Act **if** the following conditions are met.
  - The use of hazardous chemicals is under the direct supervision or guidance of a technically qualified individual;
  - Personnel training requirements (described below) are fulfilled;
  - Labels on incoming containers of chemicals are not removed or defaced;
  - The contents of secondary containers should be identified.
  - MSDS access requirements are satisfied;
- **Technically Qualified Individual:** An individual with a professional education and background working in the research or medical fields, such as a physician, a registered nurse, or a person holding a college bachelor's degree in science.
- **Workplace:** *Usually* a single building (e.g., BioBio) or complex of buildings (e.g., Chemistry) where similar work activities are conducted. EHSD designates workplaces at TAMU.
- **Work Area:** Room, lab or defined space within a workplace where hazardous chemicals are present, produced, used, or stored and where employees are present.

The TEXAS A&M UNIVERSITY HAZARD COMMUNICATION PROGRAM includes the following required components. *See GUIDE TO REGULATORY COMPLIANCE FOR RESEARCH LABORATORIES (Below)*

- **Written Programs and Implementation Plans**
  - **Workplace Implementation Plan** Each *workplace* must have a written plan that describes how the TAMU Hazard Communication Program is implemented in that workplace. Attachment I is to be completed by the designated workplace or department official, (not by each Principle Investigator or Supervisor). A copy of the *Workplace Implementation Plan* for your workplace (department or building) should be available in your department office. It is be advisable to keep copies of each *Work Area Implementation Plan* form within the designated workplace.

- **Work Area Implementation Plan** Each *work area* should have its own implementation plan. This can be accomplished by completing Part I of this Manual for your research laboratory (or work area). In order to assure compliance, users should not alter the actual text of the Manual.
- **Note:** There are instances in which granting agencies require grantees to have a Chemical Hygiene Plan (as specified by the OSHA Lab Standard) in place. The THCA does not include a lab standard component. However, the completed Chemical Safety Manual fulfills the requirements of the OSHA Lab Standard.

♦ **Hazardous Chemical Inventory**
♦ Inventory requirements generally apply to quantities of 50 gallons or 500 pounds within a building or workplace. *Thus inventory of most chemicals in research laboratories is not required.* (See "Research Laboratory Exemptions" above).
♦ **Labeling Of Hazardous Materials**
♦ Containers must be fully labeled;
♦ The contents named on the container label must be the same as on the corresponding MSDS.
♦ Employees must have access, within one work shift, to MSDSs.
♦ **Employee Information And Training**
- Employee training is a major requirement of the THCA. Employees must be provided two levels of training: General and Specific. The General Training requirement can be satisfied by completion of (a) the EHSD Introduction to Laboratory Safety Training Course or (b) the EHSD HazCom General Training Course, or (c) as provided by the supervisor.
- Employees must be provided training before potential exposure to hazardous chemicals. There is no requirement to repeat General Training.
- Additional training must be provided when a new hazard, or significantly increased hazard is introduced into the work area.

♦ Forms to facilitate documentation of employee training are included in Attachment II. Once this manual is completed by the supervisor, *Work Area Specific Training can be accomplished by reading the Chemical Safety Manual, applicable Material Safety Data Sheets and understanding the information provided.* The short video that was previously part of the TAMU HazCom Training Program is obsolete and no longer used.
♦ **Record Keeping**
- Training records must be maintained for 5 years. Workplace inventory records are maintained by EHSD.
- Certification of completion of required training should be reported as required by the Workplace Implementation Plan.

GUIDE TO REGULATORY COMPLIANCE FOR RESEARCH LABORATORIES

The "Hazard Communication and Chemical Safety Manual" is intended to provide a simple means for Research Laboratory Supervisors to assure that their unit is in compliance with the Hazard Communication regulations; the TAMU Hazardous Waste Program; and the Texas DPS requirements regarding Controlled Laboratory Apparatus and Chemicals.

PART 1. BASIC REQUIREMENTS

Step 1 Obtain a copy of the "Workplace Implementation Plan" and attach it to this document as "Attachment A."

Step 2. Fill in the blanks on pp. 1 and 2 to prepare a "Work Area Implementation Plan."
This provides the location of employee training records, how/where to locate/access safety information, etc. Suggest preparing a simple diagram of the lab (Work Area) that shows where the former are located.

Step 3. Inform and Train Employees
Employees must be provided Hazard Communication information and training BEFORE they have potential exposure to hazardous materials. Supervisors are responsible for assuring that these requirements are fulfilled. Training requirements include:

a. Information about the TAMU HazCom Program. New employees receive this as part of their Orientation. Other employees can be provided this by attending either of two EHSD training sessions: "Hazard Communication" (1 hour) or "Introduction to Laboratory Safety" (3 hour). Both are offered periodically by EHSD. There is no requirement to repeat this training. Employees must be provided general and specific information and training on the hazardous materials to which they

might be exposed.

General Laboratory Safety Training must include items 1 - 5 in Attachment II. Knowledge and understanding of the information in) and Part III Working with Hazardous Laboratory Chemicals and Appendix C (TAMU Hazardous Waste Program) of the Manual. Attendance to the 3-hour "Introduction to Laboratory Safety" satisfies this requirement. There is no requirement to repeat this training.

Specific Training must include items 6 - 9 in Attachment II. This must include training on the specific hazardous materials and conditions in the employee's work area. Specific training is required when a new hazardous material is introduced, or if a current hazard is significantly increased in the work area. Chemical-specific training can be accomplished if the employee reads and understands the MSDS and/or other appropriate safety/hazard information. Suggest attaching a copy of the MSDS, etc to the Manual. The supervisor is responsible for providing Specific Training.

b. Employee Training Records should be maintained in the Department Personnel File and as an attachment to the Manual (optional).

Step 4. The item on p. 3 refers to a "Memorandum of Understanding" that on Laboratory Apparatus and Chemicals. This is a plan to prevent diversion of laboratory equipment and chemicals to an illicit drug operation. Post the "IMPORTANT NOTICE" (See Appendix A) in the Work Area and make employees aware of the context of the Memorandum of Understanding

LABORATORY SAFETY RULES AND PROCEDURES Optional

Part IV of the Manual provides a series of safety rules and other laboratory safety topics. It is designed to be customized to fit the needs of your laboratory / work area. Suggest attaching a copy of procedures / protocols that are used in your laboratory. Other protocols that address specific procedures are accessible through the Environmental Health and Safety Department web site (http://ehsd-online.tamu.edu) or by contacting EHSD at 845-2132. All text documents are in Microsoft Word 97 to enable “fill-in-the-blank” sections to be completed.

==========

For information or comments concerning content, please contact Donald E. Clark, Ph.D., Chemical and Biological Safety Officer, Environmental Health and Safety Department, at (979) 845-2132. Dr. Clark is the principle author of this Manual.

TABLE OF CONTENTS

PART I. WORK AREA HAZARD COMMUNICATION IMPLEMENTATION PLAN

This Plan includes information and records to document compliance of this laboratory with the TAMU Hazard Communication Program (TAMU HazCom) and the Workplace Implementation Plan. Copies of these documents should be attached. A copy of the TAMU HazCom can be obtained from EHSD (also on the EHSD Website). To assure compliance with the TAMU HazCom, the following documentation must be available:

- Work Place Implementation Plan *[a blank copy is in Attachment I.)* Attach a completed form to the Manual.
- Work Area Implementation Plan *[complete Part I of this Manual]*
- Completed record of training *[complete a separate form for each employee from Attachment II]*
- A copy of the most current version of the TAMU HazCom Program *[attach copy]*

Note: Although not required by the Texas Hazard Communication Act, Instructors are responsible for providing appropriate safety information and direction to students (non-employees) enrolled in laboratory classes if class work involves hazardous chemicals. Record keeping is not required for non-employees.

LOCATION OF PERSONNEL TRAINING RECORDS: Nancy McHugh Room C115

Training records are maintained for at least five years.

LOCATION AND ACCESS TO HAZARD AND SAFETY INFORMATION

Access to MSDSs and other information on hazardous materials is available from the Environmental Health and Safety Department (845-2132) and through the EHSD Homepage (http://EHSD-online.tamu.edu). Click on "MSDS" and follow the instructions. After-hour access to MSDS is available through the EHSD Homepage or by calling TAMU Telecommunications Center (845-4311), ask for assistance from EHSD.

Location of Laboratory MSDS File: B102, B113
Location of Computer for accessing MSDS Files: B105
Location of Department MSDS Files: Reference/Library Room A104

Diagram Of Work Area (See Attachment III)

Diagram should show the location of the following:
- Personal protective equipment and supplies
- Hazardous materials and equipment (e.g. lasers,
- First aid and emergency equipment and supplies

HAZARD WARNING SIGNS

Warning signs (e.g. radioactivity hazards, biological hazards, fire hazards, and laser operations) are appropriately posted in laboratory areas with special or unusual hazards. Other signs are posted to show the locations of safety showers, eyewash stations, exits, and fire extinguishers. Hazardous waste containers must be properly labeled.

Location of Hazard Warning Signage: *[Complete the following]*
- Location of Emergency Information and Evacuation Plan**: Enterance to B101, B102, and B113 Evacuation plan is posted opposite the entrance to B101.**
- Postings for Exits and emergency equipment Entrance to B101, B102, and B113

- Warning signs posted at areas or equipment where special or unusual hazards exist; Radiation signs at the entrances to B102_____
- Posting of areas where food / beverage preparation, consumption and storage are permitted. **B110**
- Other signage: _____

[Complete the Following, if Appropriate]

Unusual abbreviations, codes, symbols, nomenclature etc used in this lab to identify hazardous materials. _____

LABELING HAZARDOUS CHEMICALS

Each primary container (as received from the supplier) must be fully labeled. The label must include the following:

- Name and address of the manufacturer
- Identity of the contents (Must be the same as appears on the MSDS).
- Physical and health hazards, including target organs.

Missing or illegible labels must be replaced.

Complete labeling of each secondary container in research laboratories is not required. However, the contents of secondary containers must be marked so that they are readily identifiable by persons not associated with the lab (e.g., emergency or spill responders).

WORK AREA CHEMICAL INVENTORY

Although not required, it is prudent to maintain an inventory list of ***significant quantities***[1] of particularly hazardous materials[2] present and used in a work area. The chemical inventory should contain the following elements: chemical name, Chemical Abstract Service (CAS) number, maximum on hand, storage location and the name of the user. Electronic inventory systems may be used, and should be readily accessible to anyone needing that information.

PECURSOR CHEMICALS AND LABORATORY APPARATUS

A Memorandum of Understanding (MOU) between The Texas Department of Public Safety and the Texas Higher Educational Coordinating Board established procedures for maintaining controlled substances and their analogs, chemical precursors, and chemical laboratory apparatus used in educational or research activities at institutions of higher education. The objective of the MOU is to heighten the awareness regarding the potential problem of the diversion of laboratory chemicals and apparatus to illegal drug operations. The list includes many common pieces of laboratory equipment in additional to possible precursors for the manufacture of illicit drugs. See **APPENDIX A** for the Implementation Plan of this MOU at Texas A&M University.

---

[1] Significant quantity of hazardous material means an amount, volume or concentration of any hazardous material with potential to cause injury, property damage or adverse environmental consequences in case of exposure, release or other accident.

[2] PARTICULARLY HAZARDOUS MATERIALS INCLUDE THOSE THAT ARE:

Extremely toxic	Highly reactive, unstable or explosive
Known human carcinogens	NFPA Class A flammable liquids
Reproductive toxins	Infectious agents ($\geq$ BL-3)
Sensitizers and/or allergens	

Any material which, because of quantity present, use or other conditions, may be particularly hazardous.

PART II CHEMICAL LABORATORY SAFETY PLAN

It is essential for everyone involved in laboratory operations to be safety minded. Safety awareness must be a part of every person's habits and each must accept responsibility for conducting all work in accordance with good safety practices. Good safety practices include adherence to the principles of laboratory safety, exercising due diligence and prudence in the laboratory, and avoiding actions that increase risk to themselves and others. Each person must be prepared, in advance, for possible accidents by knowing what emergency equipment is available and how it is to be used. Every laboratory worker has a basic responsibility to himself and colleagues to plan and execute laboratory operations in a safe manner.

The laboratory supervisor has overall safety responsibility for ensuring that: (a) employees are properly trained and follow safety rules; (b) adequate emergency equipment (in proper working order) is available; (c) emergency equipment is provided and personnel are trained in its use; (d) information on special or unusual hazards in non-routine work is provided.

PRINCIPLES OF LABORATORY SAFETY

Every person working in this laboratory is expected to:

- Know and follow the safety rules and procedures that apply to the work being done. Be aware of the potential hazards (physical, chemical, biological) and institute appropriate safety precautions before beginning any new operation;
- Know the location of and proper use of emergency equipment, emergency procedures, and how to obtain additional help in an emergency;
- Know the types of personal protective equipment available. Use the appropriate personal protective equipment;
- Be alert to unsafe conditions and actions and advise the supervisor for prompt corrections;
- Not store or consume food or beverages or apply cosmetics in areas where hazardous chemicals are being used or stored;
- Handle and dispose of laboratory waste in accordance with the TAMU waste disposal procedures;
- Use traps or scrubbing devices to prevent the escape of hazardous substances;
- Keep the doors to hazardous chemical areas closed for security, fire containment, and escape of fugitive odors;
- Be certain that all chemicals are correctly and clearly labeled. Post warning signs when unusual hazards (i.e., radiation, laser operations, flammable materials, biological hazards) or other special conditions exist;
- Not distract or startle any other worker. Practical jokes or horseplay will not be tolerated at any time;
- Use equipment only for its designed purpose;
- Position and clamp reaction apparatus appropriately to permit manipulation without the need to move the apparatus until the entire reaction or procedure is completed. Combine reagents in appropriate order, and avoid adding solids to hot liquids;
- Think, act, and encourage safety until it becomes a habit;
- Avoid working alone when using hazardous chemicals or procedures.

STRATEGIES FOR MINIMIZING EXPOSURE TO HAZARDOUS MATERIALS

ENGINEERING CONTROLS can be very effective and are the preferred method for reducing personnel exposures. The most common engineering controls used at TAMU are general-area ventilation systems (HVAC), chemical fume hoods and biological safety cabinets. Laboratory ventilation should be in compliance with NFPA 40 (National Fire Prevention Association).

- General laboratory ventilation is designed to replace exhausted air and provide the temperature, humidity and air quality required for the laboratory procedures without creating drafts at exhaust hoods. Airflow should be from areas of low hazard through areas of higher hazard. Air that is exhausted from laboratories should not be returned to any part of a building.
- Work with volatile toxic or flammable chemicals should be conducted in a fume hood that is exhausted to the outside *(Activated charcoal filtered units are not acceptable substitutes for direct exhaust hoods)*. The fume

hood(s) provide an average of 100-125 linear feet per minute (fpm) of airflow at the hood face with no part less than 70 fpm. Keep the hood sash fully closed except as necessary for manipulation of equipment or other operations.

- Other engineering controls such as local exhausts and glove boxes may be used for special ventilation purposes. Contact EHSD (845-2132) for additional information if special ventilation or other engineering controls are needed.
- EHSD and the TAMU Physical Plant Department share responsibility for evaluation and maintenance of engineering controls at TAMU. EHSD evaluates chemical fume hoods and local exhausts annually or as necessary, for proper operation and airflow. Sash level stickers indicating the maximum sash operating height and the evaluation date are placed on the fume hood when it is surveyed.
- EHSD approval is required prior to installation, relocation or modification of any laboratory local exhaust ventilation equipment or component. Do not modify any ventilation or exhaust equipment without EHSD approval.
- If fume hoods have alarms to indicate hood failure, alarms are tested, at least annually, by EHSD and should be checked periodically by lab personnel.
- Biological Safety Cabinets (BCS), are designed, when fitted with HEPA filters to remove particulates from the air. *A BSC, does not provide protection from chemical vapors unless vented to the outside and exhausted air is not returned into the room.*
- Biological Safety Cabinets that are used for work with hazardous particulate material must be certified annually through a contract coordinated by EHSD.
- Contact EHSD immediately if there is reason to believe that any engineering control (e.g., fume hood, BSC, glove box, local exhaust) or alarm is not functioning properly..
- Contact Physical Plant (Area Maintenance) for repair or maintenance of a fume hood.

ADMINISTRATIVE CONTROLS include establishing and enforcing safety rules and standard operating procedures; protocol review; and reducing potential personnel exposure by substitution of a less hazardous material, rotation of personnel, and work schedule modification. The **Laboratory Safety Rules and Procedures** in Part IV are intended to enhance the safety and health of laboratory employees.

PART III WORKING WITH HAZARDOUS CHEMICALS

A. LABORATORY CHEMICALS THAT PRESENT PHYSICAL HAZARDS

1. CORROSIVE CHEMICALS

Corrosive chemicals (solids, liquids and gases) destroy living tissue by chemical action at the site of contact. Direct contact with corrosive chemicals, especially inorganic alkali hydroxides, can severely damage living tissue. All hydrogen halides are serious respiratory irritants and also cause severe burns. Hydrofluoric acid (even at low concentrations) is particularly dangerous. Corrosives are the most common health hazards encountered in the laboratory environment.

a. General Characteristics

- Inorganic acids and bases are common laboratory corrosives. Other materials (oxidizing, reducing, and dehydrating agents) can be severely corrosive to living tissue.
- Corrosives can cause visible destruction or irreversible alterations at the site of contact. Extent of tissue damage, for each agent, is directly related to concentration and length of exposure at the site of contact. Inhalation of the vapor or mist can cause severe bronchial irritation. Corrosives are particularly damaging to the skin and eyes.
- Some chemicals that are non-corrosive when dry, or are corrosive when wet (e.g. when in contact with moist skin or mucus membranes). Lithium chloride, halogen fluorides, and allyl iodide are examples.
- Sulfuric acid is a very strong dehydrating agent and nitric acid is a strong oxidizing agent. Dehydrating agents can cause severe burns to the eyes due to their affinity for water. Many oxidizing agents are also corrosive.

b. Examples of Corrosives

sulfuric acid	bromine
chromic acid	ammonium hydroxide
stannic chloride	fluorine
hydrofluoric acid	phenol
inorganic hydroxides	acetic acid
ammonium bifluoride	chlorine

c. Use and Storage of Corrosives

- Always store acids separately from bases. Many acids are also strong oxidizers, therefore should be isolated from flammables.
- Do not work with corrosive chemicals unless an emergency shower and continuous flow eyewash are available.
- Add acid to water: never add water to acid.
- Store on a low shelf or cabinet; never above eye level.
- Containers of corrosive chemicals should be placed in a secondary container (e.g. tray or bucket to contain any leakage).
- Corrosives should be purchased in plastic-coated containers.
- Store corrosives in a wooden or corrosion-resistant cabinet.

d. Use and Storage of Hydrofluoric Acid

- Hydrofluoric acid is extremely hazardous and can cause severe burns. Initial skin contact with hydrofluoric acid may not produce any symptoms. Inhalation of anhydrous hydrogen fluoride can be fatal.
- Hydrofluoric acid should be used only by persons fully trained on its hazards and safe handling procedures.
- Hydrofluoric acid should be used only in a properly functioning fume hood. Personnel must wear appropriate protective clothing.
- If direct contact with hydrofluoric acid is suspected, contaminated clothing must be removed immediately, the area must be washed with water for at least 15 minutes, and immediate medical attention must be sought. If hydrogen fluoride vapors are inhaled, the victim must be immediately

moved to an uncontaminated atmosphere (if safe to do so), kept warm, and provided prompt medical attention.

- Never store hydrofluoric acid in a glass container.
- Store hydrofluoric acid separately in an acid storage cabinet and keep only that amount necessary in the lab.
- Creams for treatment of hydrofluoric acid exposure are commercially available.
- Hydrofluoric acid treatment kits should be available in the laboratory.

e. Health Hazards Associated with Corrosives

Acute Health Effects:

- Inhalation - irritation of mucous membranes, difficulty in breathing, uncontrolled coughing, and pulmonary edema.
- Ingestion - irritation and burning sensation of lips, mouth, and throat; pain in swallowing; swelling of the throat; painful abdominal cramps; vomiting; shock; risk of perforation of the stomach.
- Skin Contact - burning, redness and swelling, painful blisters, profound damage to tissues. Alkalis may feel slippery or soapy.
- Eye Contact - stinging, watering of eyes, swelling of eyelids, intense pain, ulceration of eyes, loss of eyes or vision.

Chronic Health Effects:

Symptoms of chronic exposure vary greatly between corrosive chemicals. For example, the chronic effect of hydrochloric acid is damage to the teeth; the chronic effects of hydrofluoric acid are decreased bone density, fluorosis, and anemia; the chronic effects of sodium hydroxide are unknown.

f. First Aid

- Inhalation - remove person from source of contamination if safe to do so. Get medical attention. Keep the victim warm and quiet and do not leave unattended.
- Ingestion - remove person from source of contamination. Get medical attention and inform emergency responders of the name of the chemical swallowed.
- Skin Contact - remove person from source of contamination and take immediately to an emergency shower or source of fresh, running water. Remove clothing and jewelry from affected areas immediately. Flush the affected area with fresh running water for a minimum of 15 minutes. Get medical attention.
- Eye Contact - remove the victim from the source of contamination. Immediately rinse the eyes with water for a minimum of 15 minutes. Have the person look up and down and from side to side. Get medical attention. Do not let the person rub their eyes.

g. Personal Protective Equipment

Neoprene and nitrile gloves are effective against most acids and bases. Polyvinyl chloride (PVC) is also effective for most acids. A rubber coated apron and goggles should also be worn. If splashing is likely to occur, wear a face shield over the goggles. Always use corrosives in a chemical fume hood. Contact EHSD for assistance in selection of appropriate PPE.

2. FLAMMABLE SOLVENTS

Flammable liquids are the most common chemicals (often in large volumes) found in a laboratory. The primary hazard associated with flammable liquids is their ability to readily ignite and burn. It is the vapor of a flammable liquid, not the liquid itself that ignites and causes a fire. (TABLE 1)

a. Definitions

- *Vapor pressure* The rate at which a liquid vaporizes is related to its *vapor pressure*. Liquids with high vapor pressures are more volatile than those of lower vapor pressure. The vapor pressure (and the rate of vaporization) of a liquid increases rapidly as its temperature is raised or as atmospheric pressure decreases.
- The *flash point* of a liquid is the lowest temperature at which a liquid gives off vapor at such a rate as to form an air:vapor mixture that will ignite, but will not sustain ignition. The flashpoint of several solvents is significantly lower than room temperature.
- The *limits of flammability or explosivity* define the range of fuel:air mixtures that will sustain combustion. The lower limit of this range is called the *Lower Explosive Limit* or LEL, and the higher limit of this range is called the *Upper Explosive Limit* or UEL. Materials with very broad flammability ranges (e.g., acetylene, LEL = 3%, UEL = 65%) are particularly hazardous because almost any fuel:air combination may form an explosive atmosphere. The vapors produced by evaporation of a very small volume (1-2 ml) of a flammable solvent in a confined space (e.g., refrigerator) can be well above the LEL.
- The *vapor density* of a flammable material is the density (mass to volume ratio) of the corresponding vapor relative to air under specific temperature and pressure conditions. A flammable vapors with vapor density greater than one (i.e. “heavier” than air) is hazardous because they will accumulate at floor level and flow in a liquid-like manner. This action can create a potential fire or explosion hazard if it reaches an ignition source.

Factors that determine flammability of several common laboratory solvents are shown in TABLE 1.

b. Use and Storage of Flammable Solvents

- Store flammable liquids in fire resistant storage cabinets designed for flammables, or inside storage rooms.
- Minimize the amount of flammable liquids kept in the lab. (See Table 2, Recommended Maximum Quantities of Flammable Liquids Within a Research Laboratory).
- Do not leave flammable solvents on the counter or on open shelves.
- Use flammables only in areas free of ignition sources.
- Dispensing and receiving containers must be bonded together (to prevent sparks from static electricity) before transfer by pouring.
- Never heat flammables with an open flame. Instead, use steam baths, water baths, oil baths, hot air baths, sand baths or heating mantles.
- Never store flammable chemicals in a standard household refrigerator. Flammables can only be stored cold in a "lab safe" or explosion-proof refrigerator.

NOTE: Most TAMU science laboratories are not protected by a sprinkler system.

3. HIGHLY REACTIVE CHEMICALS

"Reactive" applies to a broad category of chemicals, including potent oxidizing or reducing agents, unstable chemicals and substances capable of exploding, decomposing and/or reacting violently in the presence of water, oxygen, static or light. They may react to produce toxic or explosive gases. Reactive chemicals exhibit moderate to extremely rapid reaction rates and include materials capable of rapid release of energy by themselves (self-reaction, or polymerization), and/or rates or reaction that may be increased by heat, pressure or by contact with incompatible substances.

Reactive chemicals are broadly classified into two groups: those that may explode, and those that will not. The reactivity potential of similar chemicals within the same chemical class (e.g., alkali metals) varies considerably and may also unpredictable because of aging or contamination.

Reactives may be further subdivided and placed into six classes based upon their chemical behavior.

Class I: Chemicals that are normally unstable and readily undergo violent change without detonating. This class includes:

- Pyrophorics - spontaneous ignition in presence of air or water (e.g., metal alkyls, phosphorus and finely divided metal powders such as magnesium, aluminum, and zinc). *Prevent contact with air or water; use and store in inert environments.*
- Polymerizables - spontaneous polymerization in contact with air (e.g.,divinyl benzene*). Keep cool and avoid direct sunlight and contact with water*.
- Oxidizers - violent reaction in contact with organic materials or strong reducing agents. Chemical oxidizing agents present fire and explosion hazards on contact with combustible materials. Depending on the class, an oxidizing material may increase the burning rate of combustibles with which it comes in contact; cause the spontaneous ignition of combustibles with which it comes in contact; or undergo an explosive reaction when exposed to heat, shock, or friction. Most oxidizers are corrosive.

Minimize the amounts for procedure; do not keep excessive amounts of material in the vicinity of process; store properly, away from organic materials, flammable materials and reducing agents.

Examples of Common Oxidizers:

Oxygen, oxides, dioxides, peroxides	Chlorates, perchlorates, chlorites, hypochlorites
Bromates, perbromates	Iodates, periodates
Sulfates, persulfates	Chromates, dichromates, peroxychromates
Nitrates, nitrites	Permanganates
Bromine, chlorine	Perchloric, chromic and fuming nitric acids

- Peroxide-Forming Materials- Peroxide-forming materials are chemicals that react with oxygen (including air), heat and light to form peroxides. Peroxides are very unstable, and some chemicals that can form explosive peroxides are commonly used in laboratories. This makes peroxide-forming materials some of the most hazardous substances found in a lab. The tendency to form peroxides by most of these materials is greatly increased by evaporation or distillation. Organic peroxides are extremely sensitive to shock, sparks, heat, friction, impact, and light. Many peroxides formed from materials used in laboratories are more shock sensitive than TNT. Just the friction from unscrewing the cap of a container of an ether that has peroxides in it can provide enough energy to cause a severe explosion.

  Peroxide-forming compounds can be divided into three hazard categories. Storage times are based on time after opening container. (Table 3)

  - Compounds forming peroxides that can spontaneously decompose during storage. Maximum storage time = 3 months.
  - Compounds forming peroxides that require the addition of a certain amount of energy (distillation, shock) to explosively decompose. Maximum storage time = 12 months.
  - Compounds that have the potential to form peroxide polymers, a highly dangerous form of peroxide which precipitate from solution easily and are extremely heat and shock-sensitive. Maximum storage time = 12

months.

- How to Determine the Presence of Peroxides

  *Organic Peroxides, (*Three Volumes) D. Swern, Ed., Wiley-Interscience, New York

  Kelly, R. J., *Review of Safety Guidelines for Peroxidizable Organic Compounds*, Chemical Health and Safety, 3 (5) 28-36 (1996).

- Safety Precautions:
  - Date all peroxidizable chemicals upon receipt and upon opening. Do not open any container which has obvious crystal formation around lid.
  - Other precautions are similar to those used for flammables.

Reducing Agents

Chemical reducing agents react strongly with oxidizers.

Examples of Common Reducing Agents and Groups:

Hydrogen	Hydrides	Carbides	Hypophosphides
Sulfides	Hydrazines	Arsines	Silanes
Stibine	Phosphine	Borane	Metallic acetylides
Organic lithium compounds		Phosphorus (red, white, yellow)	

Class II: Water Reactive Substances: Many chemicals are unstable and are highly reactive in the presence of water, including:

- Chemicals that react exothermically in contact with water; some decompose in moist air and violently decompose in water. (e.g., sulfuric acid, chlorosulfonic acid, oleum, phosphorous trioxide and pentoxide, acetyl halides, phosphorus halides, titanium tetrachloride, glyoxal). Handling precautions are similar to corrosives: use protective acid resistant rubber or plastic clothing with gloves and face shield; keep away from moisture; handle materials in fume hood since fuming in moist air can result in exposure to corrosive and/or toxic gases.
- Chemicals that decompose violently in water with evolution of heat and flammable gases which may ignite if exposed to ignition source (e.g., alkaline metals, alkaline earth metals, alkaline metal hydrides, and alkaline metal nitrides). Evolution of heat with water may be sufficient to cause auto-ignition (and explosion). When using these chemicals: provide ventilation to disperse flammable gases; avoid contact with moisture; in case of fire, use dry sand to smother flames (Use of water as a fire extinguisher may aggravate fire).
- Chemicals that, in the presence of water, generate toxic gases, vapors or fumes in quantity sufficient to present a danger to human health or the environment (e.g., alkaline metal phosphides, phosphorus halides, aluminum phosphide, toluene diisocyanate).

These chemicals must be opened or used only inside a properly operating fume hood. Containers must be tightly sealed and away from moisture.

Class III: Compounds that produce hydrogen cyanide or hydrogen sulfide gases on contact with acids or with materials that form acids in the presence of moisture or water (e.g., inorganic cyanides or sulfides).
Isolate these chemicals from acids, oxidizers and moisture. Use only with adequate ventilation and respiratory protection.

Class IV: Chemicals that detonate or explode if heated under confinement. Detonation or explosion can occur if heated above ambient temperature or if exposed to an initiating source such as shock, mechanical shock, spark or flame, or a catalyst, which accelerates decomposition.
Examples: lead amide, sodium amide, thallous nitride, metal azides, brominated organic compounds, benzene diazonium salts, ammonium picrate, ammonium tetrachromate, metal periodates, organic perchlorates, isoamyl nitrite, ammonium nitrate or chlorate.

Chemicals in this class may also be flammable, corrosive (acidic), water reactive or light sensitive.

Protect containers from physical damage, heat and isolate from incompatible chemicals. Users must be thoroughly familiar with the hazardous properties of the materials prior to use.

Class V: Chemicals that detonate, undergo explosive decomposition, or react at ambient temperature and pressure without any external initiating source. (e.g., ammonium chlorate, organic azides, metal azides, benzoyl peroxide, peroxidized ethers).

Only knowledgeable and trained individuals should handle these compounds. Inspect and evaluate containers and chemicals periodically for evidence of deterioration. Minimize quantity in stock and dispose of excess frequently. Check the MSDS for information on incompatibles for storage and chemical properties of materials handled. Use appropriate personal protective equipment.

Class VI: Forbidden explosives as defined in 49 CFR 173.51 , or a Class A explosive as defined in 49 CFR 173.53 or a Class B explosive as defined in 49 CFR 173.88. Forbidden explosives are capable of detonation or explosive decomposition under ambient conditions and are considered too dangerous for transportation. Examples: diethylene glycol dinitrate, unstabilized nitroglycerine, nitrocellulose. Class A Explosives: Trinitrotoluene, mercury fulminate, diazodinitrophenol, lead 2, 4-dinitroresorcinate. Class B Explosives: stabilized nitrocellulose, stabilized nitroglycerin. *The presence of these materials is not permitted on the TAMU campus or in TAMU facilities without prior written approval from EHSD.*

B. WORKING WITH TOXIC CHEMICALS

Toxic chemicals are those that harm tissue (e.g., skin, eye), an organ (e.g., liver, kidney), a system (e.g., respiratory, nervous) by disruption of a biochemical process (e.g., transport, excretion), or by disturbing an enzyme system or other function at a site *remote from the site of contact*. The inherent toxicity of a substance is a function of it's molecular structure and physical state.

"Dose-Response" or "the Dose Makes the Poison" is a basic principle of Toxicology. In other words, there are conditions or circumstances in which exposure to any substance can be harmful, and there are conditions that exposure to the same substance is harmless. Those factors include conditions of exposure (dose, time), route of exposure (inhalation, dermal) and the subject (gender, reproductive status, prior exposure, age, health, nutrition, and life style factors).

The most important of those factors is the dose-time relationship, which is the basis for distinguishing between "acute" and "chronic" toxicity. Acute toxicity refers to the capacity of a substance to inflict biological damage as result (usually) of a single exposure to a sudden, relatively large exposure. In most cases, acute exposure results in an immediate, emergency situation. Hydrogen cyanide is an example of a potent acute toxin.

Chronic toxicity refers to the capacity of a substance to inflict biological damage as a result of repeated, relatively low exposure over an extended period of time where response is not immediate. Chemically-induced carcinoma is an example of chronic toxicity.

The response to chemical exposure can range from mild and reversible (headache from inhaling solvent vapors that disappears when the victim gets fresh air) to severe and irreversible (liver, kidney or neurological damage from excessive inhalation of chlorinated solvents). The toxic response depends on the severity of exposures. Greater exposure and repeated exposure generally lead to more severe effects. Toxic agents can cause local effects, systemic toxic effects, or both.

1. PRINCIPLES OF CHEMICAL SAFETY

Minimize all chemical (especially "routine") exposure

- Avoid producing aerosols
- Protect against cuts and punctures
- Use appropriate personal protective equipment
- NEVER PIPETTE BY MOUTH

Assume that mixtures or reaction products are more hazardous than the components or reactants

Do not underestimate risk

2. CHEMICALS WITH HIGH ACUTE, OR UNKNOWN TOXICITY (PROCEDURE A)

a. GENERAL PRECAUTIONS

Use appropriate precautions to minimize exposure to highly toxic substances by any route. The same precautions are also appropriate when less toxic substances are used in quantities, or under conditions that might result in toxicologically significant exposure or release. These precautions also apply to work with materials of unknown toxicity. (See Table 4 "**Health Hazard Rating: Acute Toxicity**)

1) Maintain appropriate security. Store and use acute toxins only in areas of restricted access. Post appropriate warning signs. Keep doors closed when occupied and locked when unattended.
2) Conduct work in a chemical fume hood (with a face velocity of at least 100 linear feet per minute) or other containment device for procedures which may result in the generation of hazardous aerosols or vapors. Use appropriate trap(s) to prevent release of vapors into the hood exhaust.
3) Protect against dermal exposure by using gloves and long sleeves (and other protective apparel as appropriate). Be sure that the personal protective equipment is appropriate to provide necessary protection. Wash hands and arms frequently and immediately after working with these materials.
4) Prevent contamination of items such as doorknobs, telephone receivers and other common use equipment.

5) Maintain inventory, use and disposal records (including quantity, concentration used and workers involved).

6) Avoid working alone. At least two persons should be present at all times if the compound used is highly toxic or of unknown toxicity.

7) Prevent Spills and Accidents
   - Be prepared for accidents and spills.
   - Store breakable containers in chemically resistant trays. Conduct procedures and mount apparatus above containment trays or cover work and storage surfaces with removable, adsorbent, plastic backed paper.
   - If a major spill occurs outside the hood, evacuate the area immediately. Assure that cleanup personnel wear suitable protective apparel and equipment. Notify your supervisor immediately.

8) Waste
   - Thoroughly decontaminate contaminated clothing or shoes or dispose of them as hazardous waste. Use chemical decontamination only if practical and safe.
   - Store highly toxic contaminated waste in closed, suitably labeled, impervious containers
   - Dispose of waste properly. See **APPENDIX B**

B. Airborne Chemicals

1) Work involving volatile chemicals with a maximum recommended concentration in air of less than 50 ppm must be conducted in an operating fume hood, glove box vacuum system, or similar device. The device must be equipped with appropriate traps and/or scrubbers. DO NOT work with these chemicals unless appropriate containment equipment is available.

2) If a recommended exposure level in air is not available for that substance for animals or humans, consider median inhalation lethal concentration information, (LC_{50}). Any procedures involving materials with an LC_{50} less 200 ppm or 2000 mg/m^3 (continuous exposure for one hour or less) must be conducted in an operating fume hood, glove box, vacuum system, or similar equipment. If appropriate containment equipment is not available, no work should be performed using that material.

3) Personal Protective Equipment should be always be used with volatile chemicals. As a minimum, protective eyewear and a lab coat should be worn. Nitrile and neoprene gloves are effective against most flammable solvents. Wear a non-flammable lab coat and goggles if splashing is likely (Contact EHSD for assistance in selecting PPE).

4) Always use a fume hood while working with flammable liquids.

See Vapor Pressure of Laboratory Solvents in Table 1

C. Chemical Allergens and Sensitizers

A chemical allergy is an adverse reaction by the immune system sensitized resulting from previous exposure to that chemical or a structurally similar chemical. Once sensitization occurs, allergic reactions can result from exposure to extremely low doses of the chemical. Allergic reactions can be immediate or delayed. Anaphylactic shock is a very severe, immediate and life-threatening reaction that must be treated as a medical emergency. A wide variety of chemical and biological substances can illicit symptoms of dermal and respiratory hypersensitivity. Examples of chemicals that can cause an allergic reaction include diazomethane, chromium, nickel, bichromates, formaldehyde, isocyanates, and certain phenolics.

1) Use a fume hood and appropriate personal protective equipment to prevent dermal and respiratory exposure.
2) Individuals should avoid exposure to substances to which they are sensitive or allergic.

3. CHEMICALS WITH HIGH CHRONIC TOXICITY (PROCEDURE B)

Examples: known human carcinogens (especially those with high vapor pressure), substances with high carcinogenic potency in animals, reproductive toxins and substances that cause other delayed effects.

In addition to all the **"General Precautions"** in **Procedure A**, the following supplemental rules (**Procedure B)** must be followed for work with toxicologically significant quantities or concentrations of substances of known or potential high chronic toxicity. Factors such as volatility, concentration, complexity of manipulations, worker experience and qualifications, etc. should be considered in determining risk of significant exposure or release.

a. Conduct all transfers and work with these substances in an area of a lab designated for use of highly toxic substances (e.g. controlled or restricted-access area, restricted access hood or glove box, etc.). All persons with access must be aware of the substances being used and precautions necessary to prevent exposure. The controlled area should be conspicuously marked with warning and restricted access signs. Containers of these substances must be appropriately labeled with identity and warning labels.

b. A written plan for use and disposal of these materials must have the signed approval of the laboratory supervisor.

c. Protection of equipment and surfaces from contamination:
   1) Vacuum pumps must be protected against significant contamination by scrubbers or HEPA filters (if appropriate) and vented into the chemical fume hood.
   2) Contaminated vacuum pumps or other equipment including glassware must be decontaminated before removing them from the controlled area or properly disposed as hazardous waste.
   3) Any contaminated space, including the "controlled area" must be decontaminated promptly, and prior to resumption of normal work.

d. Protective apparel must be removed and placed in an appropriate, labeled container. Do not wear potentially contaminated apparel outside the controlled area. Wash hands, forearms, face, and any other exposed skin thoroughly before leaving the work area.

e. Clean floors with a wet mop or a vacuum cleaner equipped with a HEPA filter. Do not dry-sweep.

f. A qualified physician should be consulted concerning the need for regular medical surveillance if employees are using toxicologically significant quantities of a chronic toxicant. See *Medical Consultations and Examinations*, below.

g. Maintain accurate inventory, use (amount used, date and user) and disposal records.

h. Have available contingency plans, equipment, and materials to minimize exposures of personnel and property in case of accident or spills.

i. Containers of chemicals with high chronic toxicity should be stored only in a ventilated, limited access area in appropriately labeled, unbreakable, chemically-resistant, secondary containers.

j. The ventilation rate for a negative pressure glove box should be at least two-volume changes per hour and minimum pressure of at least 0.5 inches of water. Positive pressure glove boxes should be thoroughly checked for leaks before each use. In either case, the exhaust should be trapped or filtered through a HEPA filter and exhausted through a fume hood.

k. Utilize chemical decontamination procedures whenever possible. Containers of contaminated waste (including washings) should be transferred from the controlled area in an appropriate secondary container under the supervision of authorized personnel.

4. REPRODUCTIVE TOXINS

Reproductive toxins (Examples: organomercurials, inorganic heavy metal compounds, formamide) are substances that have adverse effects on human reproduction including fertility, gestation, lactation, and general reproductive function. Developmental toxins are those that act during pregnancy to cause adverse effects on the embryo or fetus. These substances can be embryotoxic (lethality i.e., death of the fertilized egg, the embryo, or the fetus), teratogenic (malformations), retarded growth and postnatal functional deficiencies.

Relatively little is known about the effects of occupational chemical exposure on human reproductive function. Therefore, it is prudent for all workers (regardless of gender or reproductive status) to minimize chemical exposure. Cigarette smoking, excessive consumption of alcohol and certain drugs are among the substances associated with the greatest reproductive risk for humans. Nursing mothers should minimize exposure to lipophilic chemicals.

a. Workers with reproductive potential should handle volatile reproductive toxins only in a hood with confirmed performance, using appropriate protective apparel to minimize dermal and respiratory exposure.

b. The use of known reproductive toxins should be reviewed and evaluated at least annually or whenever a procedural change is made.

c. These chemicals shall be properly labeled and stored in an adequately ventilated area inside an unbreakable secondary container.

d. Supervisors shall be notified of all incidents of exposure or spills.

e. Employees should consult with their physician regarding specific questions about reproductive risk.

5. ANIMAL WORK WITH CHEMICALS OF HIGH CHRONIC TOXICITY

a. Prior approval of the University Laboratory Animal Care Committee (ULAC) is required for any protocols involving the use of laboratory animals. See the *Texas A&M University Animal Care and Use Handbook.*

b. Animal care personnel should wear protective clothing and/or respiratory devices as appropriate. Maintain strict control on all chemical containers and contaminated materials. The TAMU Environmental Health and Safety Department can recommend procedures for decontamination of caging material. Volatility, concentration and other risk/safety factors may be considered when determining containment needed. Errors should favor safety.

c. All personnel with potential for exposure to any hazardous chemical must be informed of the chemical agent being used and the possible health hazards.

d. Restricted access to critical areas should be implemented.

e. Administration of the substance by injection or gavage is preferred over dietary administration. If dietary administration is necessary, a caging system under negative pressure or under laminar airflow through HEPA filtration should be used.

f. Follow procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces (e.g. use HEPA filtered vacuum equipment for cleaning; moisten contaminated bedding before removal from the cage; mix diets in closed container in a hood).

g. Wear protective eyewear, plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit when working in the animal room. Other apparel and equipment (shoe and head coverings, respirator) may be required if suppression of aerosols is incomplete. Do not wear potentially contaminated apparel outside the controlled area.

h. Dispose of contaminated animal tissues and excreta by incineration or through the TAMU Hazardous Waste Disposal Program.

6. CHEMICALS PRODUCED IN THE LABORATORY:

a. If the chemical composition is known and the chemical is produced exclusively for the laboratory of origin, the supervisor will determine if it is hazardous.

b. If the material is hazardous, the supervisor will provide and document training (e.g., toxicological properties, safe handling procedures) per Attachment C.

c. If the chemical produced is a by-product with an unknown composition, the supervisor shall assume that the substance is a hazardous chemical and shall implement all procedures in this Laboratory Safety Manual.

d. If the product is sold to a user outside the lab, the supervisor may be required to comply with the Texas Hazard Communication Act, including preparation of MSDS and labeling. Contact EHSD for more information on these requirements.

7. MEDICAL CONSULTATIONS AND EXAMINATIONS

Health assessments prior to work assignment and periodic medical surveillance may be required under certain circumstances. Your Department or College may have an occupational health program designed to evaluate certain high-risk situations involving chemical or biological agents. If such a program is unavailable, the employee should consult with their personal physician.

8. CHEMICAL MONITORING OF THE WORKPLACE

EHSD can assist in both the assessment and monitoring of employees' exposures to chemical agents. Personal monitoring is used to determine if safe levels of exposure are being maintained in the work area to protect employee health. Contact EHSD for an evaluation or to arrange for monitoring.

PART IV LABORATORY SAFETY RULES AND PROCEDURES

It is impossible to design a set of laboratory safety rules that address all potential hazards and occurrences. However, accidents and injuries can be avoided by using good judgement and by following general safety guidelines and prudent practices, which are applicable to any laboratory situation.

These procedures and requirements are established to improve laboratory safety, avoid accidental release of hazardous chemicals and to minimize the risk of personnel exposure. Additional information on lab safety, chemical safety, etc. is available in the TAMU Safety Manual section of the EHSD Homepage or by contacting EHSD.

A. PRUDENT PRACTICES

All persons are expected to exercise due care, good judgement and follow prudent practices including:

1. Treat all chemicals as if they were hazardous;
2. Minimize exposure to any chemical;
3. Avoid repeated exposure to any chemical;
4. Never underestimate the potential hazard of any chemical or combination of chemicals;
5. Assume that a mixture or reaction product is more hazardous than any component or reactant.

B. CHEMICAL HYGIENE

1. Mouth pipeting is prohibited; use a pipet bulb or an aspirator.
2. Wash potentially exposed skin surface frequently, and before leaving the laboratory area. *(Do not use solvents for washing the skin. They remove the natural protective oils from the skin and can cause irritation and inflammation, and may facilitate absorption of a toxic chemical.)*
3. Confine long hair and loose clothing when in the laboratory.
4. Avoid exposure to gases, vapors, and aerosols.
5. Shorts and open toed shoes should not be worn in the lab unless covered by protective clothing.

C. FOOD AND DRINKS IN THE LABORATORY

Contamination of food, drink, and tobacco products are potential routes for oral exposure to toxic substances. Food and beverages may be stored, handled, and consumed ONLY in an area that is designated to be free of potentially toxic substances. Do not use laboratory chemicals (e.g., NaCl, sugar), glassware or equipment for storage, preparation, or use of materials intended for human consumption.

Do not bring food or drinks or use tobacco products or apply cosmetics in laboratories, or other areas where radioactive, or hazardous biological or chemical materials are present. Do not store, use or dispose of consumable items in laboratories (including refrigerators within laboratories). Rooms that are adjacent, but separated by floor to ceiling walls, and where hazardous substances are not present, may be used for these activities at the discretion of the supervisor responsible for the area(s). Do not use laboratory ice for human consumption.

Location where storage, preparation and consumption of food, drinks etc ARE, or ARE NOT permitted are indicated in the Laboratory Diagram (Attachment III).

D. PERSONAL PROTECTIVE EQUIPMENT

Laboratory employees must be furnished appropriate personal protective equipment (PPE) if potential exposure cannot be effectively controlled by engineering and administrative controls. Contact EHSD for assistance in selection of PPE.

1. Appropriate eye protection MUST ALWAYS be worn anytime there is a risk of injury from chemical contact or airborne dust, particle or penetrating objects. Additional eye and face protection should be worn, as needed (e.g., radiation, laser). Contact lens may be worn in the lab. However, contact lens and normal corrective glasses cannot be a substitute for wearing other personal eye protective equipment.
2. Use protective apparel, including face shields, gloves, and other special clothing or footwear as needed. Do not wear potentially contaminated protective clothing outside the lab area. Clean lab coats regularly (special washing may be required). Do not wash contaminated lab clothing with other clothing. Treat contaminated

disposable clothing as hazardous waste.

3. Equipment for protection of the respiratory system, skin and clothing must be provided and should be worn as appropriate. Assurance of proper fit is required whenever the use of respiratory protective equipment is necessary. Contact EHSD prior to wearing a respirator.
4. Appropriate PPE can be determined by consulting the MSDS or by requesting assistance from EHSD. [***Complete the Following]***

Personal Protective Equipment is required as follows.
Eye and hearing protection is required of the users of the rock saws, drill press core samples, rock crushers and some operations in the use of the thin section equipement.

There are no routine chemistry lab procedures, though PPE is available as needed.

D. **CHEMICAL FUME HOODS**

Use the hood for all operations that might result in release of flammable, toxic or malodorous chemical vapors or dust. A hood or other local ventilation device must be used when working with any air-borne substance with a permissible concentration in air of less than 50 ppm.

1. Confirm adequate hood performance before use.
2. The fume hood sash should be kept closed at all times except when necessary for manipulations within the hood.
3. Minimize storage of materials in the hood.
4. Do not use a fume hood for long-term storage of chemicals or equipment.
5. Do not allow blockage of vents or disruption of airflow.
6. Leave the hood "ON" if volatile or toxic substances are stored or if needed to assure adequate general laboratory ventilation.
7. Place equipment and other materials at least six inches behind the sash to assure proper airflow and to reduce the escape of chemical vapors into the lab.
8. Raise large equipment ~1.5 inches off the work surface to allow air to flow underneath.
9. Do not allow loose papers, paper towels, or tissues (e.g., Kimwipes®) to be drawn into the exhaust duct.
10. Do not place objects in front of a fume hood (such as refrigerators or lab coats hanging on the manual controls) that might interfere with airflow.

See "*Strategies for Minimizing Exposure to Hazardous Chemicals*; See Table 4 *"Health Hazard Rating: Acute Toxicity*

DO NOT install, remove, relocate or modify any hood or exhaust system without prior approval by EHSD.

F. CHEMICAL STORAGE

1. Store chemicals by hazard class. Maintain adequate separation of incompatible chemicals.
2. Store flammable solvents and strong acids or bases separately and in appropriate cabinets.
3. Secure compressed gas cylinders (strap, chain or cylinder stand).
4. All stored chemicals must be in appropriate containers, tightly sealed, properly labeled, and in good condition.
5. Flammable materials must not be stored in refrigerated equipment, unless the refrigerator is specifically designed for that purpose.

G. HAZARDOUS WASTE

1. Become familiar with, and carefully follow the instructions in **APPENDIX B**
2. Containers used for collection of hazardous waste must be in good condition, must not leak, and must remain closed except when waste is added. Containers and contents must be compatible. Do not overfill hazardous waste containers (Allow at least 10% headspace for liquid expansion).
3. Triple rinse, deface the labels, and remove lids before disposing of empty containers
4. Do not combine incompatible chemical waste. (Call EHSD for information).
5. Hazardous waste containers must be properly labeled. All components must be identified on the label (for example, 10% ethanol, 10% xylene, 80% water) and label as “Hazardous Waste”.

6. Do not dispose of hazardous chemicals by disposal down the drain, intentional evaporation or disposal in the regular trash.
7. When a container is ready for disposal, attach a completed EHSD waste tag to the container. (Specify location for storage of hazardous chemical waste awaiting disposal) Send the lower portion to EHSD (Mail Stop 4472) to schedule pickup.

H. SPILLS

Every lab should have immediate access to equipment and supplies to cleanup the largest container of every type of hazardous material in the work area.

In the event of a *small, contained spill** and/or until assistance from the EHSD is obtained, follow these steps:

1. If the substance is dry and/or nonvolatile, shut off hoods, close windows and doors, and vacate rooms. Label door with appropriate warning. Allow the aerosol to settle for about 30 minutes before reentering room.
2. If the substance is volatile, leave ventilation on and vacate room. Close the door and post warning.
3. Notify the laboratory supervisor.
4. Assemble materials necessary for decontamination and don appropriate protective clothing, i.e., disposable lab coat, gloves and splash goggles. If respiratory protection is needed, seek assistance from supervisor or EHSD.
5. For a liquid carcinogen or other hazardous chemical spill, wipe up the spill with absorbent material. Wash down all surfaces with the decontaminating solution appropriate to the nature of the material.
6. For a dry chemical or biological spill, wash down all surfaces with an appropriate solvent to neutralize or deactivate and remove the substance.
7. Place all contaminated materials in impermeable containers and seal. Properly remove and bag protective clothing and follow appropriate disposal procedures.

**A small contained spill of hazardous material is one that can be managed by a single person who, when wearing proper PPE, will not encounter excessive exposure, other hazardous condition (e.g. fire, explosion) or release of highly odoriferous or noxious materials. Any other spill is a "large spill" requiring activation of the TAMU Spill Response Team through the TAMU Physical Plant Operator (845-4311)*

I. HOUSEKEEPING IN THE LABORATORY

There is a definite relationship between safety performance and orderliness in the laboratory. Lab personnel are individually and collectively responsible for maintaining the work area in a clean and orderly fashion.

1. Keep work areas clean and free from obstructions. Hallways, corridors, aisles and exit routes must ALWAYS be kept clear and free of obstructions. Do not allow emergency equipment, electrical panels, and such to be blocked. Do not use hallways or stairways for storage.
2. Cleanup should follow the completion of any operation or at the end of each day.
3. Clean and dispose of spilled chemical and cleanup waste promptly and properly.
4. Dispose of unneeded chemicals, empty containers, etc. Do not allow unneeded items to accumulate and create clutter.
5. Floors should be cleaned regularly. Accumulated dust, chromatography adsorbents, and other powdered chemicals and materials may pose respiratory hazards.
6. Store equipment and chemicals properly; minimize clutter.

J. FACILITY AND EQUIPMENT MAINTENANCE

Good equipment maintenance is important for safe, efficient operations. Equipment should be inspected and maintained regularly. The risk and the consequences of failure should determine servicing schedules. DO NOT ATTEMPT TO USE EQUIPMENT KNOWN TO BE FAULTY.

1. Use equipment only as it was intended. Follow the manufacturer's instruction manual closely. Do not deactivate or defeat safety devices.
2. Inform the supervisor of equipment malfunctions or unsafe conditions.

3. Contact Physical Plant, Area Maintenance ***[Add your Area Maintenance Group's Number]*** (845-_____) promptly in case of utility or building equipment failure.
4. Contact EHSD for information or assistance regarding fume hood or local exhaust operation or testing.

K. GUARDING AND SHIELDING FOR SAFETY

All mechanical equipment should be furnished with guards that prevent access to electrical connections or moving parts (such as the belts and pulleys of a vacuum pump). Inspect equipment before use to ensure that the guards are in place and functioning.

Use safety shielding for any operation having the potential for implosion or explosion such as:

1. when a reaction is attempted for the first time (small quantities of reactants should be used to minimize hazards);
2. whenever a familiar reaction is carried out on a larger than usual scale (e.g., 5-10 times more material);
3. whenever operations are carried out under non-ambient conditions. Locate shields such that all personnel in the area are protected from the hazard.

L. LABORATORY GLASSWARE

Accidents involving glassware are a leading cause of laboratory injuries.

1. Use care in handling and storage procedures to avoid damaging glassware. Damaged items should be discarded or repaired.
2. Use appropriate hand-protection when inserting glass tubing into rubber stoppers or corks, or when placing rubber tubing on glass hose connections. Tubing should be fire polished or rounded and lubricated. Hold hands close together to limit movement of glass should fracture occur. Use plastic or metal connectors (instead of glass connectors) when possible.
3. Handle vacuum-jacketed glass apparatus with extreme care to prevent implosions. Tape or shield equipment such as Dewar flasks.
4. Use heavy-walled, silica glassware (Pyrex, Kimax, etc.) for work involving non-ambient pressure or temperature work.
5. Use hand protection when picking up broken glass. (Use a brush to sweep small pieces into a dustpan.)
6. Seek instruction in the use of glass equipment designed for specialized tasks. (For example, separatory funnels containing volatile solvents can develop considerable pressure during use.)

M. FIRE PREVENTION IN THE LABORATORY

Observe the following rules when using flammable materials in laboratory operations:

1. NEVER use an open flame to heat a flammable liquid or for vacuum distillation.
2. Use an open flame only when necessary and extinguish it when it is no longer actually needed.
3. Do not light a flame unless all flammable substances are removed from the immediate area. Be sure that containers of flammable materials in the area are tightly closed.
4. Notify other occupants of the laboratory before lighting a flame.
5. Store flammable materials properly. Separate flammable chemicals from oxidizers.
6. Use only non-sparking electrical equipment when volatile flammable materials may be present.
7. Minimize quantities of flammable solvents in the lab. (See Table 2: *Recommended Maximum Quantities of Flammable Liquids in Research Laboratories*

N. VACUUM SYSTEMS

Glass vacuum systems pose severe implosion hazards. Follow these guidelines and requirements to system safety:

1. Ensure that pumps have belt guards in place during operation.
2. Ensure that service cords and switches are free from defects.
3. Always use a trap on vacuum lines to prevent vapors from being drawn into the vacuum pump, building vacuum line, or water drain.
4. Replace and properly dispose of vacuum pump oil that is contaminated with condensate. Used pump oil must be disposed as hazardous waste.
5. Place a pan under pumps to catch oil drips.
6. Do not operate pumps near containers of flammable chemicals.

7. Do not place pumps in an enclosed, unventilated cabinet.

IMPORTANT: All glass vacuum equipment is subject to possible implosion. Conduct all vacuum operations with a table shield or in a fume hood. Do not underestimate the pressure differential across the walls of glassware that can created by a water aspirator.

The glassware used with vacuum operations must meet the following requirements:

1. Only heavy-walled round-bottomed glassware should be used for vacuum operations. The only exception to this rule is specifically designed for vacuum operations, such as an Erlenmeyer filtration flask.
2. Wrap exposed glass with tape to prevent flying glass if an implosion occurs.
3. Carefully inspect vacuum glassware before and after each use. Discard any glass that is chipped, scratched, broken, or stressed.

When possible, use molded plastic desiccators with high tensile strength or a perforated metal desiccator guard for glass desiccators.

O. COLD TRAPS AND CRYOGENIC HAZARDS

A cold trap is a condensing device to prevent liquid contamination in a vacuum line. Guidelines for using a cold trap include:

1. Locate the cold trap between the system and vacuum pump.
2. Ensure that the cold trap is of sufficient size and cold enough to condense vapors present in the system.
3. Check frequently for blockages in the cold trap.
4. Use isopropanol/dry ice or ethanol/dry ice instead of acetone/dry ice to create a cold trap. Isopropanol and ethanol are less expensive, less toxic, and less prone to foam.
5. Do not use dry ice or liquefied gas refrigerant bath as a closed system. These can create dangerous uncontrolled high pressures.

Extreme cold is the primary hazard of cryogenic materials (e.g., liquid oxygen, liquid nitrogen, dry ice). Cryogens and the surfaces they cool can cause severe burns if allowed to contact the skin. Use gloves and a face shield if needed when preparing or using some cold baths.

1. Do not use cryogens to cool a flammable mixture in the presence of air. Oxygen (from the air) can condense on the surface of the container resulting in an explosion hazard.
2. Use appropriate dry gloves when handling dry ice.
3. Avoid excess frothing by adding dry ice slowly to the liquid portion of the cooling bath.
4. Do not breathe vapors or lower your head into a dry ice chest: carbon dioxide is heavier than air, and suffocation can result.

P. PRESSURIZED SYSTEMS

Do not carry out a reaction in, or apply heat to, a closed system unless it is designed and tested to withstand pressure. Pressurized apparatus should have an appropriate relief device. Use an inert gas ebulator system to avoid bubbling or pressure buildup for reactions that cannot be opened directly to the air.

Q. UNATTENDED OPERATIONS

Avoid unattended operations. When it is necessary to carry out laboratory operations continuously or overnight, it is essential to plan for interruptions in utility services such as electricity, water, coolant, etc. These operations must be designed to be safe, and plans should be made to minimize hazards in case of failure. Wherever possible, arrange for routine inspection of the operation and, in all cases, leave the laboratory lights **ON** and place an appropriate sign on the door.

R. WORKING ALONE

It is imprudent practice to work alone in a laboratory building. Arrangements should be made between individ.uals working in separate laboratories outside of working hours to cross check periodically. Do not undertake hazardous procedures, when alone in the laboratory.

Under unusual conditions, special rules may be necessary. The laboratory supervisor will determine whether the work requires special safety precautions such as having two persons in the same room during a particular operation.

S. PRIOR APPROVAL

Prior to engaging in a laboratory task, employees must obtain prior approval to proceed from the supervisor or his or her designee whenever:

1. A new laboratory procedure or test is initiated.
2. It is likely that toxic concentrations could be reached or other hazardous situations could arise.
3. There is a change in a procedure or test, even if it is very similar to prior practices. Change in a procedure or test means:
    a. A 10% or greater increase or decrease in the amount of one or more hazardous chemicals (including catalysts) used.
    b. A substitution or deletion of any of the chemicals in a procedure.
    c. Any significant change in the system or in other conditions under which the procedure is to be conducted.
4. There is a failure of any of the equipment used in the process, especially of safeguards such as fume hoods or clamped apparatus.
5. There have been previous unexpected results or potential or near accidents
6. Members of the laboratory staff become ill, suspect that they or others have been exposed, or otherwise suspect a failure of any safeguards.

T. VIGILANCE

Be alert to, and immediately report, any unsafe conditions or activities to your supervisor. Each laboratory worker should remember that injuries can and do occur outside the laboratory or other work area. It is important that safety be practiced in offices, stairways, corridors, and other places. Safety is largely a matter of common sense, but a constant safety awareness of everyday hazards is vital.

U. REGULATED OR RESTRICTED ACCESS AREAS OR PROCEDURES

Access to the following Areas or Procedures are not permitted without supervisor approval:

Labs B113, B114

HazMat structure, located adjacent to the ODP loading dock but outside and independent of the ODP buildings. It is assigned building number #1597.

V. REPORTING ACCIDENTS AND HAZARDOUS CONDITIONS

Emergency telephone numbers to be called in the event of fire, accident, water or gas leak, or hazardous chemical spill should be posted prominently in each laboratory. In addition, the numbers of the laboratory workers and their supervisors should be posted. Notify these persons immediately in the event of an accident or emergency.

ALL accidents, near accidents and hazardous conditions should be promptly reported to the laboratory supervisor. First Report of Injury Forms shall be completed and filed as required for all "Reportable Injuries." All other accidents or near accidents should be reported to EHSD or the Human Resources Department.

REFERENCES

Bretherick, L. *Handbook of Reactive Chemical Hazards,* 5th Ed., Butterworth-Heinemann, Oxford, England, 1995. (Evans Library: T55.3.H3 B73 1995)

Gershey, E. L., Party, E., Wilkerson, A., *Laboratory Safety in Practice,* Van Nostrand Reinhold, New York, 1991

Mahn, William J., *Academic Laboratory Chemical Hazards Handbook*, Van Nostrand Reinhold, New York, 1989.

Mahn, William J., *Fundamentals of Laboratory Safety, Physical Hazards in the Academic Laboratory*, Van Nostrand Reinhold, New York, 1990.

Safe Storage of Laboratory Chemicals, D. A. Pepitone, Ed., John Wiley & Sons, New York, 1984.

Prudent Practices in the Laboratory, Handling and Disposal of Chemicals, National Research Council, National Academy Press, Washington, D.C., 1995.

Steere, Norman V., *Handbook of Laboratory Safety*, Chemical Rubber Company, Cleveland, OH., 1970.

Texas A&M University Safety Manual, (http://ehsd-online.tamu.edu).

Clark, Donald E., *Peroxides and Peroxide-forming Compounds*, Chemical Health and Safety 8(5) 12-22, 2001

Clark, Donald E.. *Safety and the Laboratory Centrifuge*, Chemical Health and Safety, 8(6) 7-13, 2001.

Clark, Donald E., *Chemical Injury to the Eye*, Chemical Health and Safety, Accepted for publication, January, 2002.

TABLE 1. PROPERTIES OF VOLATILE LABORATORY CHEMICALS

Chemical	Flash Point [1]	Boiling Point [1]	Ignition Temp [1]	Flammable Limit (% by vol. in air)		NFPA Fire Hazard Category[2]
				Lower	Upper	
Acetaldehyde	-38	21.1	175	4.0	60	4
Acetic acid (glacial)	39	118	463	4.0	20	2
Acetone	-17.8	56.7	465	2.6	12.8	3
Acetonitrile	6	83	524	3	16	3
Benzene	-11.1	80	540	1.3	7.1	3
Carbon disulfide	-30	46	80	1.3	50	3
Cyclohexane	-20	82	245	1.3	8.0	3
Diethylamine	-23	57	312	1.8	10	3
Diethyl ether	-45	35	160	1.9	36	4
Dimethyl sulfoxide	95	189	215	2.6	42	1
Ethyl alcohol	13	78.3	365	3.3	19	3
In water 95%	17					
80%	20					
60%	22					
40%	26					
n-Heptane	- 3.9	98.3	215	1.1	6.7	3
n-Hexane	-21.7	68.9	225	1.1	7.5	3
Isopropyl Alcohol	11.7	82.8	399	2.0	12	3
Methyl alcohol	11.1	64.9	385	6.7	36	3
Methylethyl ketone	- 6.1	80.0	516	1.8	10	3
Pentane	-40.0	36.1	260	1.5	7.8	4
Styrene	32.2	146	490	1.1	6.1	3
Tetrahydrofuran	-14	66	321	2	12	3
Toluene	4.4	111	480	1.2	7.1	3
p-Xylene	27.2	138	530	1.1	7.0	3

[1](^{O}C) [2]National Fire Protection Association (NFPA 704)

[2]NFPA HAZARD CATEGORY

Fire Hazard (Flash points)	Reactivity	Health Hazard (Acute)
4 = Extremely flammable(<23 C)	4 = Unstable, may detonate	4 = Extreme hazard
3 = Highly flammable (23-39C)	3 = May detonate if initiated	3 = High hazard
2 = Flammable (39-93C)	2 = Violent chemical change at high T or P	2 = Moderate hazard
1 = Combustible (>93C)	1 = Normally stable; May be unstable if heated	1 = Low hazardous
0 = Will not burn	0 = Stable	0 = Normal material

TABLE 2. RECOMMENDED MAXIMUM QUANTITY[1] OF FLAMMABLE LIQUIDS WITHIN A NON-SPRINKLERED[2] RESEARCH LABORATORY

	FLAMMABLE LIQUID CATEGORY				
CONTAINER TYPE	4	3	2	1	0
Glass	1 L	2 L	4 L	4 L	20 L
Metal or Approved Plastic	4 L	4 L	4 L	4 L	20 L
Safety Can	8 L	8 L	8 L	8 L	20 L
Metal Drum	N/A[3]	N/A	N/A	N/A	120 L

[1]Quantities based upon proper storage within a Flammable Solvents Storage Cabinet
[2]Most TAMU research laboratories are NOT sprinklered [3]N/A = Not allowed

Limit the total combined volume of Class 4 + 3 flammable liquids within a laboratory to 10 L.

TABLE 3. PEROXIDE FORMING CHEMICALS

a. Chemicals that form explosive levels of peroxides without concentration. Severe peroxide hazard after prolonged storage, especially after exposure to air. All have been responsible for fatalities. *Test for peroxide formation or* ***discard after 3 months.***

(di)isopropyl ether
potassium metal
sodium amide
divinyl acetylene
potassium amide
vinylidene chloride

b. Peroxide hazard on concentration. *Test for peroxide formation before distillation or evaporation. Test for peroxide formation or discard after 1 year.*

Acetal
Acetaldehyde
Benzyl alcohol
Cumene (isopropylbenzene)
Cyclohexanol
Cyclohexene
Furan
4-Heptanol
2-Hexanol
Methyl acetylene
3-Methyl-1-butanol
Methyl cyclopentane

Cyclopentene
Diacetylene (butadiene)
Decahydronaphthalene (decalin)
Dicyclopentadiene
Diethylene glycol dimethyl ether (diglyme)
Diethyl ether
Dioxanes
Ethylene glycol ether acetates (cellosolves)
Vinyl ethers
Methyl-isobutyl ketone
4-Methyl-2-pentanol
2-Pentanol
4-Penten-1-ol
1-Phenylethanol
2-Phenylethanol
Tetrahydrofuran
Tetrahydronaphthalene
Other secondary alcohols

c. Chemicals, which are a hazard due to, peroxide initiation of autopolymerization. The peroxide forming potential increases for liquids of this group, especially for butadiene, chloroprene and tetrafluoroethylene, such that these materials should be considered as a peroxide hazard. *Test for peroxide formation or discard after 1 year.*

Acrylic acid
Acrylonitrile
Butadiene
Chlorobutadiene
Chlorotrifluoroethylene
Methyl methacrylate
Styrene
Tetrafluoroethylene
Vinyl acetate
Vinyl acetylene
Vinyl chloride
Vinyl pyridine
Vinyldiene chloride

TABLE 4. HEALTH HAZARD RATING: ACUTE EXPOSURE

Relative Hazard	Ingestion LD_{50} mg/Kg	Inhalation LC_{50} (ppm), 1 hr exposure	Eye Contact (Liquid)	Skin Penetration LD_{50}, ml/Kg	Skin Irritation
4	**< 1**	**< 20**	**Extremely corrosive**	**< 0.02**	**Necrosis – 10% soln.**
3	**> 1 - 50**	**> 20 - 200**	**Corrosive, Irreversible corneal opacity**	**> 0.02 – 0.2**	**Necrosis - Undiluted**
2	**> 50 - .5K**	**>.2K– 2K**	**Irritating, reversible corneal opacity ≥ 7 days**	**> 0.2 – 2.0**	**Erythema & Slight edema from undiluted**
1	**>.5K – 5K**	**> 2K – 10K**	**Slightly irritating**	**> 2.0 - 20**	**Slight erythema - undiluted**
0	**> 5K**	**> 10K**	**Non-irritating**	**> 20**	**Non-irritating**

0 = relatively non-hazardous; 1=low hazard; 2=moderate hazard; 3=high hazard; 4=extreme hazard

Appendix A

PRECURSOR CHEMICALS AND LABORATORY APPARATUS IMPLEMENTATION PLAN

IMPLEMENTATION AT TEXAS A&M UNIVERSITY OF THE OCTOBER, 1995 TEXAS HIGHER EDUCATION COORDINATING BOARD MEMORANDUM OF UNDERSTANDING ON CONTROLLED LABORATORY APPARATUS AND CHEMICALS

The Texas Department of Public Safety (DPS) and the Texas Higher Education Coordinating Board (HECB) signed a Memorandum of Understanding (MOU) that establishes responsibilities on institutions of higher education for implementing and maintaining a program for reporting information concerning controlled substances, controlled substance analogues, chemical precursors, and chemical laboratory apparatus used in educational or research activities. This document defines the requirements and procedures necessary for compliance with the MOU by Texas A&M University. Full text of the MOU is available from the TAMU Environmental Health and Safety Department (845-2132).

The objective of this plan is to define institutional procedures for the use of controlled items (chemical precursors and certain laboratory equipment and glassware) in the facilities of Texas A&M University, College Station.

Please distribute the Implementation Plan to all persons affected. Post "**IMPORTANT NOTICE**" (BELOW) in areas where controlled items are ordered, received, used or stored.

The following is a list of the controlled items including precursor chemicals, laboratory apparatus and glassware whose purchase, use, transfer and disposal must be monitored.

Precursor Chemicals	**Laboratory Apparatus**
Methylamine	Condensers
Ethylamine	Distilling apparatus
D-Lysergic acid	Vacuum dryers
Ergotamine tartrate	Three-necked flasks
Diethyl malonate	Distilling flasks
Malonic acid	Tableting machines
Ethyl malonate	Encapsulating machines
Barbituric acid	Filter funnels, Buchner funnels, and separatory funnels
Piperidine	Erlenmeyer flasks, two-necked flasks, single-necked
N-Acetyl anthranilic acid	flasks, round-bottom flasks, thermometer flasks, and
Pyrrolidine	filtering flasks
Phenylacetic acid	Soxhlet extractors
Anthranilic acid	Transformers
Ephedrine	Flask heaters
Pseudoephedrine	Heating mantles
Norpseudoephedrine	Adapter tubes
Phenylpropanolamine	
Controlled Substance Analogue	

"Controlled substance analogue" is a substance that is substantially similar in chemical structure to that of a controlled substance or has central nervous system activity that is substantially similar to, or greater than that of a controlled substance.

NOTE: The MOU does not establish any de minimis quantities of precursor chemicals nor size of glassware or equipment.

Prescription and non-prescription medicinal formulations are exempted.

The following procedures and requirements are necessary for TAMU to comply with the MOU.

1. **RESPONSIBLE PARTY:** any person who uses or has access to, or control of the listed items, including investigators, laboratory personnel, instructors, laboratory storeroom personnel, purchasing agents and surplus property personnel.
2. **MAINTAIN PURCHASE ORDER RECORDS:** Purchase orders that include controlled items should be marked with an asterisk, highlight or some other similar manner readily distinguishable from all other items appearing on the purchase order. Purchase records are to be maintained according to State and Federal requirements, and are subject to DPS audit.

3. **DO NOT SELL, FURNISH OR TRANSFER** any controlled items (including surplus property) to a person or entity not holding a DPS permit or waiver, unless the recipient is specifically exempted by law or rule. Every sale, furnishing or transferring of a controlled item leaving the immediate campus (where the specific controlled item is stored and inventoried) should be reported (by the 15th day of the next month) to the DPS on a Nar-22 Form. EHSD personnel will assist the TAMU Surplus Property and Inventory Department in compliance with the MOU.
4. **REPORT TO THE TEXAS A&M UNIVERSITY POLICE** promptly upon discovery of a readily unacceptable discrepancy, pilferage or theft of a controlled item. UPD is responsible for forwarding the report to DPS.
5. **SECURITY**
   a. The Director of Security and University Police has primary responsibility for all matters associated with security and law enforcement on the TAMU Campus.
   b. Maintain locked storage for controlled precursor chemicals and controlled substance analogues. Strictly limit access to these chemicals. Use records should be maintained.
   c. Limit access to storerooms containing listed items to authorized personnel. Lock storage areas when unattended.
   d. All doors and windows into any rooms in which controlled items are used or stored must be locked when authorized personnel are not present.
6. **NOTIFICATION AND AWARENESS**
   a. Departments and units affected by the MOU should post in prominent and strategic location(s), notices to inform personnel of the MOU and of the steps necessary for compliance. See "**IMPORTANT NOTICE** " in Appendix E.
   b. Encourage personnel to be alert and attentive to the disappearance of controlled items and to report such losses as appropriate.
7. **ASSISTANCE FROM THE TEXAS DEPARTMENT OF PUBLIC SAFETY**
   Upon request, the DPS will provide technical advice to the institution and will assist UPD in investigating losses, etc. covered by the MOU.

If there are any questions concerning these documents, please contact Dr. Donald E. Clark, Chemical and Biological Safety Officer, Environmental Health and Safety Department (845-2132). Contact Bob Wiatt, Director of Security and University Police (845-8058) for assistance with security and police matters.

IMPORTANT NOTICE

A Memorandum of Understanding between the Texas Department of Public Safety and the Texas Higher Education Coordinating Board places record-keeping and control responsibilities on institutions, including Texas A&M University. The MOU applies to the following chemicals, laboratory glassware, equipment and controlled substance analogues.

Precursor Chemicals	Laboratory Apparatus
Methylamine	Condensers
Ethylamine	Distilling apparatus
D-Lysergic acid	Vacuum dryers
Ergotamine tartrate	Three-necked flasks
Diethyl malonate	Distilling flasks
Malonic acid	Tableting machines
Ethyl malonate	Encapsulating machines
Barbituric acid	Filter funnels, Buchner funnels, and separatory funnels
Piperidine	Erlenmeyer flasks, two-necked flasks, single-necked
N-Acetyl anthranilic acid	flasks, round-bottom flasks, thermometer flasks, and
Pyrrolidine	filtering flasks
Phenylacetic acid	Soxhlet extractors
Anthranilic acid	Transformers
Ephedrine	Flask heaters
Pseudoephedrine	Heating mantles
Norpseudoephedrine	Adapter tubes
Phenylpropanolamine	
Controlled Substance Analogue	

"Controlled substance analogue" is a substance that is substantially similar in chemical structure to that of a controlled substance or has central nervous system activity that is substantially similar to, or greater than that of a controlled substance.

NOTE: The MOU does not establish any de minimis quantities of precursor chemicals nor size of glassware or equipment. Prescription and non-prescription medicinal formulations are exempted.

PROCEDURES

The following procedures and requirements are necessary for TAMU to comply with the MOU. They apply to all persons who use or have access to, or control, any of the listed items including investigators, laboratory personnel, instructors, laboratory storeroom personnel, purchasing agents and surplus property personnel.

1. **PURCHASE ORDER RECORDS:** Identify controlled items on purchase orders by marking with an asterisk, highlight or some other similar manner readily distinguishable from all other items appearing on the purchase order. Maintain purchase records according to State and Federal requirements. Records are subject to DPS audit.
2. **SALE, FURNISHING OR TRANSFER OF CONTROLLED ITEMS (INCLUDING SURPLUS PROPERTY)** to a person or entity not holding a DPS permit or waiver, unless the recipient is specifically exempted by law or rule is not permitted. Every sale, furnishing or transferring of a controlled item leaving the immediate campus (where the specific controlled item is stored and inventoried) should be reported (by the 15th day of the next month) to the DPS on a Nar-22 Form (Available from the Surplus Property Office).
3. **REPORT TO THE TEXAS A&M UNIVERSITY POLICE** promptly upon discovery of a readily unacceptable discrepancy, pilferage or theft of a controlled item. UPD is responsible for forwarding the report to DPS.
4. **SECURITY** The Director of Security and University Police Department has primary responsibility for all matters associated with security and law enforcement on the TAMU Campus.
   a. Controlled precursor chemicals and controlled substance analogues should be locked. Access to these chemicals should be strictly limited. Use records should be maintained.
   b. Restrict access to storerooms and other areas containing listed items to authorized personnel. Lock storerooms when unattended.
   c. Laboratory doors should be kept closed and should be locked when unoccupied and during non-use periods.

5 NOTIFICATION AND AWARENESS

   a. Departments and units affected by the MOU should post a copy of this notice in prominent and strategic location(s).
   b. Be alert and attentive to the disappearance of controlled items and report such losses to your supervisor.

APPENDIX B

TAMU HAZARDOUS WASTE PROGRAM

MANAGEMENT AND DISPOSAL OF HAZARDOUS WASTE

Generators are responsible for following the University disposal procedures, for assuring that their employees are trained in proper disposal procedures, and for properly identifying the hazardous chemical waste generated. The TAMU Hazardous Waste Program (http://ehsd-online.tamu.edu/programs/environmental/environmental.htm) is intended to assure compliance with applicable Federal and State regulations for the proper management of hazardous chemical waste and to reduce adverse effects to human health and the environment.

- A **material becomes "waste"** when the individual generator determines that it is no longer useful and should be discarded. If the material is to be discarded, EHSD will determine whether the chemical waste is non-hazardous or hazardous. "Hazardous chemical waste" includes materials that are classified as "ignitable," "reactive," "corrosive," "toxic," "Universal Waste," and "Material is not excluded from regulations." Contact EHSD for assistance in categorizing chemical waste.

- **Non-hazardous waste** may be disposed of using the sanitary sewer or regular trash. Additional information about non-hazardous waste disposal can be obtained from EHSD.

- **Gas cylinders** should be returned to the manufacturer or distributor whenever possible. Non-returnable cylinders should be tagged as hazardous waste.

- **Photographic lab** waste containing **silver** must be disposed as hazardous chemical waste. However, some new developing equipment includes a filtration system that removes the **silver.** Photographic lab effluent that does not contain silver may be discarded through the sanitary sewer system. Please notify the EHSD if you have this type of equipment.

- **"Mixed Waste"** (includes both radioactive material and hazardous chemicals) should be initially routed through the EHSD Division of Radiological Safety.

- **"Unknown Waste"** is chemical waste that can't be identified by the generator. Such material should be should be identified as "Unknown" on the Waste Disposal Tag. Unknowns will be picked up by EHSD. Generators will be charged for the cost of analysis necessary to determine the chemical identity for proper disposal.

Separation and Segregation of Hazardous Waste

Hazardous chemical waste is categorized into the following hazard classes.

Halogenated solvents
Non-halogenated solvents
Acids (inorganic or organic)
Bases (inorganic or organic)
Heavy metals (silver, cadmium, lead, mercury, etc.)
Poisons (inorganic or organic)
Reactives (cyanides, sulfides, water reactive chemicals, peroxides, etc.)

- Do not commingle these classes in the same waste container.
- Do not combine inorganic heavy metal compounds and organic waste solvents.
- Do not combine non-hazardous waste (e.g., mixture of water, dilute acetic acid, and sodium bicarbonate) with hazardous chemical waste.
- Dry materials (paper, rags, towels, gloves, or Kim Wipes, etc.) contaminated with flammable or extremely toxic chemicals must be double-bagged in heavy-duty plastic bags and must be treated as hazardous chemical waste. **Do not use biohazard bags**.
- Sharps (needles, razor blades, etc.) are classified as biohazardous waste even if they are not contaminated. Sharps must be encapsulated (Place the sharps in a "puncture resistant" container or plastic/metal container and then fill it with paraffin or plaster of Paris.). Discard the containers of sharps as biohazardous waste. *Contact EHSD for additional information.*

Hazardous Waste Containers

- Waste generators are required to provide their own waste containers that are compatible with the chemical contents (e.g., do not use metal containers for corrosive waste or plastic containers for organic solvent).
- Containers must be in good condition and not leak. All containers must have suitable screw caps or other means of secure closure. When large waste containers (>10 gallons, total volume) are required, contact EHSD for assistance on selection and placement of appropriate container type and size.
- Never overfill hazardous waste containers. Expansion and excess weight can lead to spills, explosions, and extensive environmental exposure.
  - Containers of solids must not be filled beyond their weight and volume capacity.
  - Jugs and bottles should not be filled above the shoulder of the container.
  - Closed head cans) should have at least two inches (5 gallons or less) or four inches (larger than 5 gallons) of headspace between the liquid level and the head of the container.
- Containers must be closed or sealed to prevent leakage. ***All waste collection containers must be kept closed except when adding or removing material.***

Containment and Storage of Hazardous Chemical Waste

- Waste generators must maintain custody and control of the storage areas and ensure the waste is accessible to EHSD personnel.
- Individual waste generators shall assure that their hazardous chemical wastes are accumulated in safe, transportable containers, properly labeled, and stored to prevent human exposure to or environmental release of the waste materials.
- "Satellite Accumulation Areas" are locations designated by EHSD for storage of hazardous waste awaiting pickup and disposal. Consult with your supervisor or EHSD to determine the location of hazardous waste for your workplace.

Labels and Labeling

- The original chemical label on containers used for waste accumulation must be destroyed or defaced.
- EPA regulations require that waste containers be labeled with the chemical contents and the words "Hazardous Waste" **when the chemical waste is first added**.
- **DO NOT DATE THE CONTAINER UNTIL READY FOR PICKUP AND DISPOSAL**
- Containers at TAMU can be labeled in one of two methods:
  - Using string, attach a completed **Hazardous Waste Disposal Tag except for the accumulation start date** (available from EHSD) to each new waste container when the chemical is first added.
  - **Print the information on the tag legibly**.
  - For containers larger than 5-gallons, a **Hazardous Waste Label** (available from EHSD) can be used. These labels have an adhesive back and are placed on the container when the chemical is first added.

Disposal of Hazardous Chemical Waste

Waste containers that are full and/or ready for disposal are:

1. Tagged with a Hazardous Waste Disposal Tag. (See below) Fill in the accumulation start date on the disposal tag, separate the bottom part of the tag, and mail it to **MS 4472**. EHSD schedules to collect the waste upon receipt the bottom part of the tag,.
2. Labeled with a Hazardous Waste Label. Attach a completed Hazardous Waste Disposal Tag including the accumulation start date, separate the bottom part of the tag, and mail it to **MS 4472**. Upon receiving the bottom part of the tag, EHSD schedules to collect the waste. EHSD makes weekly pickups at designated Satellite Accumulation Areas.

- *EHSD will not pickup containers* with improper caps, leaks, outside contamination, or improper labeling.
- It is violation of federal and state law to dispose of hazardous chemicals in any of the following ways:
  - Disposal through the sanitary drain (sewer).
  - Intentional disposal by evaporation in a fume hood. (This does not refer to normal fume hood use).
  - Disposal in the regular trash.

Disposal of Empty Chemical Containers

Empty containers should be placed in a dumpster for disposal with other non-hazardous trash when the following requirements are satisfied.

- not contain free liquid or solid residue,
- be triple rinsed,
- have the label removed or defaced,
- have the lid or cap removed, and
- have a hole punched in the bottom (metal or plastic containers).

It is not necessary to break empty glass containers when placed in a dumpster. Empty chemical containers not handled in this manner must be treated as hazardous chemical waste (very expensive).

HAZARDOUS CHEMICAL WASTE

Contents: *(Chemical(s) identity and percentage of each component*

HANDLE WITH CARE
Contains Hazardous or Toxic Waste

Follow the example below to properly complete your hazardous waste disposal tag:

Attach An Individual Hazardous Waste Disposal Tag To **Each** Waste Container

Both upper and lower sections of the tag must be filled out completely and legibly **except for the accumulation date** when chemical is first added to a waste container. (This information is essential for record keeping).

* Fill in the **Accumulation Start Date (ONLY)** when the waste container is full and/or ready for pickup.

Secure the top part of the tag with a string that encircles the top of the container - **rubber bands, tape, and wire are not acceptable**.

** The "REQUESTOR" is the Principal Investigator or person in charge of the lab that generated the waste.

*** Chemical name/Common name. **Chemical formulas or abbreviations are not acceptable**.

*** List all chemical components in a waste container (including water). Lists may be continued on the back of the tag.

***Tags for containers of potentially explosive materials such as picric acid, silanes, nitro compounds, and ethers must indicate the percent concentration of these chemicals.

c. Place any additional Hazard Information about container contents in **REMARKS**.

(ATTACH TAG TO CONTAINER WITH STRING)

HAZARDOUS WASTE DISPOSAL TAG

REQUESTOR: ** John Doe
DEPT/PART: Chemistry .
PHONE: 5-3140
CHEMICAL(S): *** Methylene Chloride, Toluene

602

HAZARDOUS WASTE DISPOSAL TAG

ACCUMULATION START DATE: * 5/22/96
REQUESTOR: ** John Doe
DEPT/PART: Chemistry
BLDG.NAME & NO: Chemistry - 376
ROOM NO. 2002 **PHONE**: 5-3140
CHEMICAL(S): *** Methylene Chloride, Toluene .

PHYSICAL PROPERTY: ☐ Liquid ☐ Solid ☐ Gas
☐ Other _____
QUANTITY: ☐ Pint ☐ Quart ☐ Gallon ☐ 5-Gallon
☐ Other 4 liter .
CONTAINER TYPE: ☐ Glass ☐ Metal
☐ Other _____
REACTS WITH: ☐ None ☐ Air ☐ Water
☐ Other _____
HAZARDS: ☐ Flammable ☐ Explosive ☐ Carcinogen
☐ Toxic ☐ Corrosive ☐ Other_____

REMARKS:

Mail lower portion of tag to Environmental Health & Safety Department when container is ready for pickup.(MS 4472, Campus; 845-2132)

EHSD Form 15-13

ATTACHMENT I

Workplace Hazard Communication Implementation Plan

Workplace Implementation Plan Each *workplace* must have a written plan that describes how the TAMU Hazard Communication Program is implemented in that workplace. Attachment I is to be completed by the designated department official, not by each Principle Investigator or Supervisor. This form, when completed and attached to a copy of the Texas A&M University Hazard Communication Program will meet this requirement. Employees should have ready access to the TAMU HazCom Program and the Workplace Implementation Plan.

TAMU HAZARD COMMUNICATION PROGRAM

WORK PLACE IMPLEMENTATION PLAN

1. **Name of Unit:**

2. **Person(s) or position(s) responsible for assuring compliance with training requirements:**

3. **Location of Employee Training Records:**

4. **Location of Material Safety Data Sheets:**

5. **Location(s) where the "NOTICE TO EMPLOYEES" is permanently posted:**

6. **Person(s) or position(s) responsible for compiling the annual Workplace Chemical Inventory:**

7. **Location where the Workplace Chemical Inventory Records are filed:**

ATTACHMENT II

EMPLOYEE TRAINING RECORDS

Hazard Communication Training Record

I hereby acknowledge receipt of the Texas A&M University (TAMU) Hazard Communication Program Training, which includes:

GENERAL AND CHEMICAL SAFETY TRAINING

1._____information on interpreting MSDSs and labels, and the relationship between the two methods of hazard communication;
2._____general methods of obtaining MSDSs at TAMU;
3._____generic information on hazardous chemicals;
a) hazards associated with chemical hazard groups (e.g., flammables, corrosives, toxics, and reactives) including acute and chronic effects;
b) methods for identifying specific chemicals within each chemical hazard group (e.g., DOT labels, NFPA 704 System, chemical container labels);
c) safe handling procedures, including proper storage and separation of incompatibles;
4._____proper use of appropriate protective equipment to minimize exposure to hazardous chemicals and first aid treatment to be used with respect to the hazardous chemicals;
5._____general instructions on spill cleanup procedures and proper disposal of hazardous chemicals.

Instructor Name(s)(Print) _____ Date _____

WORK AREA SPECIFIC TRAINING

6._____information on hazardous chemicals known to be present in the employees work area and to which the employees may be exposed, including:
a) location within the work area,
b) specific hazards, including acute and chronic effects,
c) safe handling procedures;
7._____work area location of MSDSs, or procedures for obtaining MSDSs;
8._____how to obtain and use appropriate personal protective equipment and first aid treatment to be used with respect to the hazardous chemicals;
9._____instructions on spill cleanup procedures, and proper disposal of hazardous chemical specific to that work area.

Instructor Name(s)(Print) _____ Date _____

Employee Name(Print) _____ Employee Department _____

*Employee Signature _____ Date _____

***The employee is responsible for ensuring that this completed form is given to the person within their department/unit who is responsible for maintaining personnel records or is responsible for sending the form to the centralized personnel files.**

Attachment III

Work Area Diagram

(Diagram of work area showing location of emergency equipment & supplies, personal protective equipment, designated areas, etc. Optional, but recommended)