

Lab Safety Manual

The University of Texas at San Antonio

Office of Occupational and Safety Programs

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I. Introduction

Research and education in science laboratories involve a variety of hazards. It is the University of Texas at San Antonio's policy to protect and promote the health and safety of students and employees and the environment. Faculty, staff and students who may be exposed to hazards in the laboratory should be informed of the nature of these hazards and how to protect themselves and others who may also be exposed. Faculty, administration and research supervisory personnel are responsible for promoting safe practices and providing safe equipment and facilities for employees and students. Each person using the equipment and facilities at UTSA is expected to follow proper and safe procedures, report accidents promptly and bring unsafe conditions or practices to the attention of supervisors and faculty members. Safety in the laboratory can be achieved only with the exercise of judgment and proper use of facilities by informed, responsible individuals.

This manual discusses safe practices and procedures for research and educational laboratories. It is not intended to be a fully comprehensive reference but rather a guidebook. There may be chemicals, procedures and other circumstances in each laboratory that present unique or unusual hazards not addressed here; these hazards are best addressed by the principal investigator or supervisor of the respective laboratory.

II. Texas Hazard Communication Act

In Texas, the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard applies to private-sector businesses only. To protect public-sector businesses, the Texas legislature passed the Texas Hazard Communication Act in 1985. The law, which was revised in 1993, is also known as the Public Employers Worker Right-to-Know Act. It requires public employers to provide their employees with information on hazardous chemicals to which they may be exposed in the workplace. Requirements under the act include compiling and maintaining workplace chemicals lists, maintaining material safety data sheets (MSDS) and informing employees of the hazards associated with the chemicals they use. The law is similar to OSHA's Hazard Communication Standard but is enforced by the Texas Department of Health, Division of Occupational Health, Hazard Communication Branch.

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

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

Otherwise, all requirements of the act apply. See Appendix I, Notice to Employees, for a brief summary of the act.

A. Requirements

1. Container labels

Hazardous chemical containers must have a label that identifies the hazardous chemical and lists the appropriate hazard warnings. A label on an existing container may not be removed or defaced unless it is illegible or inaccurate or does not conform to labeling requirements. When transfers are made from the primary chemical container (stock bottle) to other containers, the secondary containers should be labeled with the name of the chemical (as it appears on the MSDS) and appropriate hazard warnings unless it is used immediately by the individual who made the transfer.

2. Material Safety Data Sheets (MSDS)

The material safety data sheets (MSDS) are an extensive compilation of chemical hazard and safe-handling information. Each sheet provides most of the information an employee needs to work with a chemical safely. Chemical manufacturers or distributors must develop an MSDS for each hazardous chemical they produce or distribute and are required to provide an MSDS with each initial shipment and with the first shipment after an MSDS is updated.

There is no required format for an MSDS, but it must include the specific chemical identity and common names of the hazardous chemical(s) involved; physical and chemical characteristics of the hazardous chemical; known acute and chronic health effects and related health information; exposure limits; whether the chemical is considered a carcinogen by the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC) or

OSHA; precautionary measures; emergency and first-aid procedures; and the identification (including name, address and telephone number) of the organization responsible for preparing the MSDS.

When chemicals are purchased by UTSA faculty and staff, the MSDS is usually sent to the Office of Occupational and Safety Programs (OSP) where a master MSDS file is maintained. If an MSDS is received with a chemical shipment, please forward a copy to OSP. Employees may request copies by writing OSP; be sure to include the full chemical name as it appears on the label and the manufacturer.

3. Training

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

OSP offers a laboratory safety class several times each semester to assist in complying with this training requirement. This class is mandatory for new laboratory employees and recommended for students. The principal investigator is responsible for having new staff attend the laboratory safety class or for providing the initial training if the employee is unable to attend. The principal investigator is also responsible for providing continued training as necessary. All training must be documented, including the date, employee names and signatures, and the subjects covered in the session. Once training is completed, principal investigators should forward a copy of the training record to OSP.

B. Responsibilities

Principal investigators are responsible for determining who among their staff falls under the act's provisions. They must see that new staff attend OSP's mandatory lab safety class. They are also responsible for training staff as needed concerning the hazards of specific chemicals in their laboratories and for ensuring compliance with the act's labeling requirements.

Staff are responsible for using only those chemicals for which they are adequately trained. They are expected to identify hazardous chemicals in the laboratory and to consult references, including MSDSs, to determine hazard characteristics and handling procedures. Staff are also expected to follow supervisors' instructions regarding the use of hazardous chemicals in the lab and to observe the guidelines in this manual.

III. General laboratory safety guidelines

Everyone in the lab is responsible for his or her own safety and the safety of others. Before starting any work in the lab, become familiar with the procedures, equipment and chemicals that will be used and learn how to protect yourself from any associated hazards. If you don't understand something, ask! Below are guidelines for working safely in a lab. See section 7 for a discussion of laboratory equipment.

A. Guidelines

1. Students should never work alone or unsupervised in the lab.
2. If you must work alone, tell someone where you'll be and have him or her check on you periodically.
3. Report dangerous activities or situations to your lab supervisors; if they do not respond promptly or appropriately, contact OSP.
4. Always incorporate safety into your experiments and anticipate and account for things that could go wrong. Never compromise safety in the interest of time.
5. Remove gloves before handling items such as the telephone, doorknobs and computer keyboards.
6. Always wash your hands thoroughly before leaving the lab.
7. Designate non-lab areas for eating and drinking. Remember, smoking is not allowed in UTSA buildings.
8. Store food and drinks in refrigerators designated for that use only.
9. Be aware of dangling jewelry, loose clothing or long hair that might get caught in equipment.
10. Avoid wearing shorts, sandals or open-toed shoes in the lab.
11. Always wear appropriate personal protective equipment.
12. Keep aisles and walkways clear and drawers and cabinet doors closed while you're working.
13. Do not store hazardous chemicals on the floor in high-traffic or open areas.
14. Never pipette anything by mouth.
15. Do not allow children into the lab.

B. Personal protective equipment (PPE)

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

1. Eye and face protection

Eye protection must meet standards for impact resistance and provide splash protection. Safety glasses with side shields usually provide adequate impact resistance with limited splash and vapor protection. Chemical splash goggles (with no perforations around the goggles) provide adequate impact resistance and splash and vapor protection and therefore provide the best all-around eye protection. In addition to protective eyewear, face shields or freestanding shields should be used in situations where implosion or explosion may occur. Follow these guidelines for effective eye and face protection.

1. Wear protective eyewear at all times in the laboratory.
2. Wear chemical splash goggles for maximum protection, especially if you wear corrective lenses (glasses or contacts).

2. Hand protection

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

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

3. Body protection

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

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

4. Respiratory protection

Respiratory protection in the laboratory is normally provided by engineering controls such as the ventilation system and chemical fume hood(s). When a higher level of respiratory protection is required, a half- or full-face respirator can be used. Contact OSP for assistance in selecting the correct respirator and cartridges. Instruction is also necessary for proper fit and use. Follow these guidelines for effective respiratory protection:

1. To note chemical odors, use a wafting motion of the hand to dilute the fumes before they reach your nose. Never inhale chemical fumes directly.
2. Do not use a respirator unless you have been trained to do so.
3. If you are wearing a respirator, be sure appropriate cartridges are used.

IV. Chemical safety

You need to be familiar with the hazardous chemical substances you are working with in the lab. Being able to recognize the physical and health hazards of a chemical before you handle it is very important. Once the potential hazards of a chemical have been determined, you can take the appropriate steps in the handling and storage of that chemical.

A. Classification of chemical hazards

The hazard a chemical presents depends on its physical and toxicological properties. Chemicals are considered a physical hazard if they are flammable or reactive (i.e., unstable—including explosives, organic peroxides, monomers, pyrophorics, and water reactives), or if they are combustible liquids, oxidizers or compressed gases. Chemicals that present a physical hazard are classified according to their hazardous properties. Chemicals that can cause reversible or irreversible damage to the human body are considered a health hazard and are classified as toxics. This classification includes systemic poisons, irritants, carcinogens, asphyxiants, teratogens, mutagens, anesthetics and corrosives. Be aware that many chemicals exhibit multiple hazards, in which case the more prevalent hazard must be considered.

1. Flammables

A flammable is any solid, liquid, vapor or gas that ignites easily and burns rapidly.

A flammable solid is a solid, other than an explosive, that ignites readily and burns vigorously. Examples: wood, paper and magnesium.

A flammable liquid is a liquid that gives off vapors readily ignitable at room temperature. The Department of Transportation (DOT) defines it as a liquid with a flash point at or below 141°F, and NFPA and OSHA define it as a liquid with a flash point below 100°F. (The flash point of a liquid is the temperature at which sufficient vapors are given off by the liquid to form an ignitable mixture with air.) Many common organic solvents have flash points well below room temperature, including acetone, ethyl ether, hexane and benzene.

A flammable gas is a gas that at normal atmospheric pressure forms a flammable mixture with air. Examples: hydrogen, acetylene and propane.

2. Combustible liquids

The DOT defines a combustible liquid as a liquid with a flash point above 141°F and below 200°F. NFPA and OSHA define it as a liquid with a flash point at or above 100°F but below 200°F. These liquids, even though not classified as flammable liquids, still present a significant fire hazard. Examples: kerosene, glacial acetic acid and phenol.

3. Reactives

A chemical is reactive, or unstable, if it has a tendency to undergo chemical reaction either by itself or with other materials with the release of energy. Undesirable effects such as pressure build-up, temperature increase or the formation of noxious, toxic or corrosive byproducts may occur because of the chemical's reactivity to heating, shock,

direct contact with other materials or other conditions in use or in storage. Reactives can be divided into the following hazards:

Explosives. A material that produces a sudden, almost instantaneous release of pressure, gas and heat when subjected to abrupt shock, pressure or high temperature. Examples: “dry” picric acid (trinitrophenol), and nitroglycerine.

Organic peroxides. An organic compound containing the bivalent -O-O- structure. These chemicals are very unstable and may be explosive. A common organic peroxide is benzoyl peroxide.

Monomers. Under appropriate conditions, monomers undergo polymerization, in which the monomers combine with each other to form repeating structural units, or a polymer. If not controlled, polymerization can occur at a rate that releases large amounts of energy that can cause fires, explosions or burst containers. Examples: formaldehyde and styrene.

Pyrophoric. A material that ignites spontaneously in air. Pyrophoric chemicals are also known as air-sensitive compounds or as spontaneously combustible. Examples: the Alkali metals (sodium, potassium) and hydrides (lithium aluminum hydride).

Water reactive. A material that by contact with water becomes spontaneously flammable or gives off a flammable or toxic gas. Examples: the Alkali and Alkaline Earth metals, hydrides (sodium borohydride) and strong acids (sulfuric acid).

4. Oxidizers

An oxidizer is a material that yields oxygen readily to cause or enhance the combustion (oxidation) of organic matter. Materials that do not contain oxygen can also be oxidizers because of their ability to accept electrons. Examples: nitrates, permanganates, dichromates, peroxides, nitric acid and chlorine.

5. Compressed gas

A compressed gas is any material that is a gas at room temperature and atmospheric pressure that is contained under pressure as a compressed, liquefied or dissolved gas. Examples: hydrogen (compressed gas), acetylene (gas dissolved in a solvent) and chlorine (liquefied gas).

6. Toxics

A toxic is any chemical that, when ingested, inhaled or absorbed, or when applied to, injected into, or developed within the body in relatively small amounts, by its chemical action may cause damage to biological structure and/or disturbance of biological function.

Damage can be local (direct) or systemic (indirect). Local toxicity is the effect of a substance on the body area that has been exposed to the substance. Systemic toxicity is the effect of a substance on body tissue after absorption into the bloodstream.

Damage can also be acute (immediate) or chronic (delayed). Acute toxicity is the effect manifested on short exposure or single contact. Chronic toxicity is the effect observed when a toxic substance acts on the body over time.

Toxicity is affected by the following parameters: routes of entry (skin, nose, mouth, eye, lungs or stomach), dose, exposure duration, physical condition and sensitivity of exposed individual, synergistic effects with other chemicals, and other parameters such as age, sex and race. Remember that all chemicals are potentially toxic—the dose makes the poison!

Toxics can be divided into the following hazards:

Systemic toxics. A material which, after it enters the bloodstream, adversely affects a particular body organ or system (target organ). Systemic toxics can be classified as

Hematotoxins. Chemicals that affect blood-forming tissues. Examples: cyanides and benzene.

Neurotoxins. Chemicals that affect the nervous system. Examples: carbon disulfide and mercury.

Nephrotoxins. Chemicals that damage the kidneys. Examples: chloroform and carbon tetrachloride.

Hepatotoxins. Chemicals that damage the liver. Examples: ethanol and carbon tetrachloride.

Irritants. A material that causes a reversible inflammatory effect on living tissue. Examples: formaldehyde, ammonia and chlorine.

Carcinogens. A material that causes cancer in humans or, because it causes cancer in animals, is considered capable of causing cancer in humans. Examples: carbon tetrachloride, formaldehyde, chloroform and benzene. See Appendix II for a list of carcinogens regulated by OSHA.

Asphyxiants. A vapor or gas that can cause unconsciousness or death by suffocation. Asphyxiants can be simple or chemical.

Simple asphyxiants. Materials that displace available oxygen in the air.
Examples: nitrogen and carbon dioxide.

Chemical asphyxiants. Materials that reduce the blood's ability to carry oxygen or interfere in the body's utilization of oxygen. Examples: carbon monoxide and hydrogen cyanide.

Anesthetics. A material that depresses the central nervous system, producing loss of sensation or feeling.
Examples: chloroform and ether.

Teratogens. A material that causes physical defects in a developing embryo. Example: lead.

Mutagens. A material that induces genetic mutations in DNA, usually by chronic exposure. Examples: ethidium bromide and formaldehyde.

Corrosives. A material that by direct action is damaging to body tissue or corrosive to metal. Damage can range from minor skin irritation to actual physical disruption of body tissue. Note that corrosives are also a physical hazard. Examples: ammonia and chlorine (gases), acids, bases, and bromine (liquids), and bases and phenol (solids).

B. Chemical safety guidelines

Chemical hazards in the laboratory are varied and numerous. You should develop a healthy respect for all chemicals, even those that are designated “safe” or “benign,” because evidence may develop indicating that continued exposure may cause unexpected or cumulative adverse effects. Never take chemical safety for granted.

Follow these general and chemical-specific guidelines for the safe handling and use of chemicals in the laboratory.

1. General guidelines

1. Be familiar with the chemicals you work with. Review the container labels and MSDSs for information on the associated hazards and how to protect yourself. The more you know about the chemicals you work with, the better you can protect yourself.
2. Always return chemicals to their proper storage location after use.
3. Perform all work with volatile and toxic chemicals in the fume hood.
4. Do not leave chemical containers open any longer than it takes to remove what you need. This will help minimize exposure and contamination of your chemicals.
5. Be sure that all chemical containers are properly labeled in your laboratory. Do not use a chemical from an unlabeled container if you are not sure of the contents.
6. Exercise great care when transporting chemicals within or between labs. When transporting chemicals between floors, use the elevator. Polyethylene or rubber acid/solvent bottle carriers or utility carts provide effective protection and containment in the event of an accident.
7. Use flammables only in an area free of ignition sources.
8. Use absorbent paper on work surfaces to help contain spills.

2. Chemical-specific guidelines

The following chemicals deserve special attention because of their extremely hazardous nature.

Ethers

Ethers such as ethyl ether, isopropyl ether, p-dioxane and tetrahydrofuran deserve special attention because of their tendency to react with oxygen from the air to form explosive peroxides. These peroxides may detonate with extreme violence when they become concentrated by evaporation or distillation or when they are exposed to unusual heat, shock or friction.

Peroxides may form in “unstabilized” ethers in as little as three days. Exposure to light and air, as in opened and partially emptied containers, accelerates the formation of peroxides in ethers. It is important to keep ether

containers tightly closed when they are not in use and to store them in a dark place. "Stabilized" ethers, which contain peroxide inhibitors, are available and should be used whenever possible.

The presence of peroxides can be determined with potassium iodide test strips, which turn black in the presence of peroxides. Once the presence of peroxides is confirmed, they can be reduced with a 30% aqueous ferrous sulfate solution (40 grams for each liter of ether). Removal of the peroxides can be confirmed by the potassium iodide test strips.

Follow these guidelines for the proper use of peroxide-forming ethers in the lab:

1. Clearly mark each container of ether with the date of receipt and the date it was first opened to ensure disposal at the appropriate time.
2. Unopened bottles of ether should be discarded after one year. Opened bottles of ethyl ether, p-dioxane and tetrahydrofuran should be discarded after six months, and isopropyl ether should be discarded after three months.
3. Test for peroxides frequently, especially when evaporating or distilling. Never distill ether to dryness.
4. If crystals are observed around the cap of a container of ether, do not open it. The friction of opening the container can be sufficient to detonate the peroxides.
5. Since ethers have a limited shelf life, they should be bought in the smallest containers possible (appropriate to the rate of usage in the lab). The cost and hazards of disposal far outweigh any of the benefits of buying in bulk.

Perchloric acid

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

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

1. Perchloric acid in concentrations greater than 70% is not recommended.
2. Any procedure involving heating of perchloric acid must be conducted in a properly functioning perchloric acid fume hood (see section 7) with the sash down.
3. Do not allow perchloric acid to come into contact with organic material or dehydrating agents.
4. Anhydrous perchloric acid should only be made as required and should never be stored. Only experienced faculty should handle anhydrous perchloric acid.

Hydrofluoric acid

Hydrofluoric acid (HF) is an extremely corrosive material. All forms, including vapors and solutions, can cause severe, slow-healing burns to human tissue, including the lungs and eyes. At concentrations greater than 50% the burning is noticeable in a matter of minutes or less, while at concentrations below 50% the burns may not be felt until several hours after exposure. Because it has a low boiling point and a high vapor pressure, HF must be kept in a nonglass pressure container.

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

1. Always use HF in a properly functioning fume hood.

2. In work involving HF, be sure to use materials that are compatible with HF. HF attacks a variety of materials, including glass, concrete, cast iron, wood, leather and rubber; lead, wax, polyethylene, polypropylene and Teflon will resist its corrosive action.
3. In HF exposures, time is crucial. Immediately wash the affected area(s) with copious amounts of water to minimize the extent and the depth of the burn. Never let a HF burn go untreated, as extensive damage could result.

Mercury

Mercury and its compounds are very common in laboratories. Because of its widespread use, the mercury's hazardous nature may be overlooked or ignored. Elemental mercury is volatile, and its vapors are extremely toxic. Because of the vapors' high toxicity, it is very important to clean up mercury spills promptly and thoroughly. If this is not done, mercury can accumulate and vaporize over time. Inorganic and organic mercury compounds are also highly toxic.

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

1. All work with elemental mercury should be performed over trays to capture and contain any spillage.
2. All work involving mercury should be done in a properly functioning fume hood.
3. Clean up all mercury spills immediately. If you do not have the appropriate spill-control equipment, do not clean the spill yourself, as you can make the situation worse by creating small droplets that can end up in inaccessible locations such as cracks and crevices. For assistance, contact OSP.
4. Be careful not to heat any surfaces that may contain mercury residue, as increased temperature greatly increases the vapor pressure of mercury.
5. Red spirit thermometers are a nontoxic alternative to mercury thermometers and should be used whenever possible.

Chemical carcinogens

Several common laboratory chemicals, such as benzene, chloroform and formaldehyde, are suspected or known carcinogens. It is prudent to treat suspected carcinogens as if they are confirmed carcinogens. These chemicals may also have other physical or health hazards that should not be overlooked.

Follow these guidelines for the safe use of carcinogens in the lab:

1. Minimize the use of carcinogens in the lab by using nontoxic or less toxic alternatives whenever permissible.
2. All work with chemical carcinogens should be done in a properly functioning fume hood.
3. All carcinogens in the lab should be labeled clearly and secured when not in use.
4. Personal protective equipment and hygiene are very important when working with chemical carcinogens. While the fume hood should provide respiratory protection, you must also protect your hands to avoid skin absorption. Particularly for solvents, be sure to use protective gloves that are resistant to the chemical you are using. Be sure to wash your hands promptly.

C. Chemical storage

Proper chemical storage within the laboratory is an essential part of an effective lab safety program.

Follow these general guidelines for the safe storage of chemicals in the lab:

1. Do not indiscriminately store chemicals in alphabetical order. This can lead to incompatible chemicals being stored next to each other. Instead, store chemicals according to their hazards—for example, flammables, corrosives, toxins, reactives, etc. For chemicals that have multiple hazards, segregate according to the most prominent hazard.
2. Flammable liquids should be stored in a flammable storage cabinet. Amounts of Class IA flammable liquids (flash point less than 73°F and boiling point less than 100°F) in the lab should be kept to a minimum.
3. Corrosives should be stored in a corrosive storage cabinet. However, acids and bases should be stored separately to prevent their mixing in the event of an accident.
4. Strong oxidizing agents should be stored away from organic materials and strong reducing agents to prevent the risk of fire and/or violent reactions in the event of an accident.
5. Cyanides and sulfides should be stored well away from acids to prevent the generation of the respective toxic gases in the event of an accident.
6. Label all new material with the date in which it was received and the date in which it was opened. This will help prevent the accumulation of outdated chemicals and ensure that older chemicals are used first.
7. Promptly discard outdated chemicals or chemicals no longer needed by the laboratory. Contact OSP for disposal.
8. Do not store chemicals in glass containers on the floor in high-traffic areas. Large metal containers can be stored on the floor in an isolated location.
9. Do not store chemicals near heat sources or in direct sunlight.
10. Be sure that all chemical containers are clearly and accurately labeled. Remember, this is required under the Texas Hazard Communication Act.
11. Periodically inspect storage locations for signs of corrosion or leakage and misplaced chemicals.
12. To avoid contact with the eyes in the event of a spill, do not store liquids above eye level.

D. Memorandum of understanding (MOU) for controlled substances and chemical precursors

1. To comply with a statutory requirement, a Memorandum of Understanding (MOU) between the Texas Higher Education Coordinating Board and the Texas Department of Public Safety has been executed. The MOU establishes the responsibilities of institutions of higher education in implementing and maintaining a program for reporting information concerning controlled substances, controlled substance analogs, chemical precursors and certain glassware and chemical laboratory apparatuses used in educational or research activities.
2. Personnel using controlled substances under the Federal Controlled Substances Act for research, instruction and the conduct analysis are reminded that they must register annually with the Federal Drug Enforcement Agency (DEA). Accordingly, no precursor chemical listed may be sold or otherwise transferred to anyone who does not have the proper permit or the specific authority to accept the controlled items. Currently, glassware and other laboratory apparatus are not regulated by the DEA, but we must track the regulated laboratory apparatuses consistent with MOU procedures.

3. Any listed precursor chemical that appears on purchase orders will be annotated by UTSA Purchasing Department and an inventory of physical locations throughout campus will be maintained. All rooms containing these chemicals should be securely locked when not in use. OSP will participate in monitoring activities involving controlled substances. Periodic internal and external audit inspections should also be anticipated. The precursor chemicals specified in the MOU are

- | | | |
|------------------------|------------------------|-------------------------|
| 1. Methylamine | 7. Ethyl malonate | 13. Anthranilic acid |
| 2. Ethylamine | 8. Barbituric acid | 14. removed from list |
| 3. D-lysergic acid | 9. Piperidine | 15. Ephedrine |
| 4. Ergotamine tartrate | 10. N-acetylanthrailic | 16. Pseudoephedrine |
| 5. Diethyl malonate | 11. Pyrrolidine | 17. Norpseudoephedrine |
| 6. Malonic acid | 12. Phenylacetic acid | 18. Phenylpropanolamine |

4. Controlled Substances

The official list of controlled substances can be found in Section 1308 of the most recent issue of Title 2 Code of Federal Regulations, Part 1300 to end. OSP has a copy of the latest Drug Enforcement Administration "List of Scheduling Actions and Controlled Substances." UTSA policy is to identify controlled substances that have been ordered and stamp the purchase order form to identify the controlled substance and requester. Central Receiving will only deliver the controlled substances to the individuals licensed and identified on the form. If the controlled substance cannot be delivered, it will be secured in Central Receiving. The requester will be notified of the receipt of the controlled substance, and delivery will be scheduled or the requester can pick it up.

V. Biological safety

Personnel who work in biological laboratories may handle or come into contact with hazardous biological agents. Over the years there have been many documented cases of lab personnel acquiring diseases, some of which were fatal, due to their work with biological agents. Proper handling and disposal of biohazardous materials greatly reduces the potential for exposure to infectious or harmful agents. This chapter presents general information and bio-safety guidelines as recommended by the Centers for Disease Control and Prevention (CDC) and National Institutes of Health (NIH). Contact OSP for details for the safe use of specific biological agents.

A. Classification of biological hazards

The NIH defines biological hazards as “agents presenting a risk or potential risk to the well-being of man, or other animals, either directly through infection or indirectly through disruption of the environment.” Biological hazards include materials or organisms known or suspected to contain any of the following: infectious agents, recombinant DNA molecules or oncogenic viruses.

1. Infectious agents (etiologic agents)

An infectious agent is a viable microorganism, or its toxin, that causes or may cause disease in humans or animals. This classification includes bacteria, viruses, parasites and fungal agents that have been assigned to Classes I through 4 on the basis of the hazards they present. Examples: Salmonella (Class II bacterial agent) and Human Immunodeficiency Virus (Class II viral agent). See Appendix III for the classification of etiologic agents on the basis of hazard.

2. Recombinant DNA molecules

Molecules that are constructed outside living cells by joining natural or synthetic DNA segments to DNA molecules that can replicate in a living cell, or DNA molecules that result from this replication.

3. Oncogenic virus

A virus that is believed to cause tumors in humans or animals. See Appendix III for a listing of oncogenic viruses.

B. Biological safety guidelines

Whenever work with biological agents is performed, appropriate steps must be taken to protect personnel and the environment. Personal protective equipment, good personal hygiene, biological safety cabinets (BSCs), proper disinfection and proper disposal play an important role in protecting lab personnel and the environment.

Detailed guidelines are available in CDC/NIH's Biosafety in Microbiological and Biomedical Laboratories and Guidelines for Research Involving Recombinant DNA Molecules. All work at UTSA involving biological agents should follow CDC/NIH guidelines.

General guidelines for the safe handling of biological agents in the laboratory

1. All work involving infectious agents must be performed in properly functioning BSCs appropriate for the agent. In the event of an accident, containment is very important for minimizing inhalation exposure.

2. Wear disposable gloves when working with infectious agents to protect against contact exposure. Other ways to control contact exposure include using absorbent paper on work surfaces and frequently disinfecting work surfaces.
3. To minimize chances of exposure due to ingestion, wash your hands thoroughly after working with biological agents and before leaving the lab.
4. To minimize chances of exposure due to inoculation, exercise extreme caution when using “sharps” such as syringes, razor blades and glass pipettes. Handle lab animals carefully, as inoculation can also occur through animal bites.
5. After using a needle, do not recap, bend or break it; remove it from the syringe; or manipulate it in any other way. Many people have accidentally inoculated themselves this way. All sharps should be promptly placed as is into the appropriate sharps container.
6. Always disinfect work surfaces when you are finished with an experiment.
7. All contaminated waste must be handled and stored properly, including disinfection, to prevent contact exposure of other lab personnel, housekeeping staff and waste-handlers.

C. Laboratory biosafety levels

The CDC and NIH describe four biosafety levels (BL) for activities involving infectious agents. The levels designate, in ascending order, degree of protection provided to lab personnel, the environment and the community. For example, BL 1 is for work with agents that pose minimal or no hazards, while BL 4 is for work with agents that pose the greatest hazard. Each level recommends facility design, lab practices and safety equipment appropriate for the infectious agents involved. A thorough discussion of biosafety level criteria can be found in CDC/NIH's Biosafety in Microbiological and Biomedical Laboratories.

1. Biosafety Level 1

BL 1 practices, safety equipment and facilities are appropriate for undergraduate teaching laboratories using microorganisms that are not known to cause disease in healthy adult humans. BL 1 represents a basic level of containment that relies on standard microbiological practices; no special primary or secondary barriers are recommended.

2. Biosafety Level 2

BL 2 practices, safety equipment and facilities are recommended for clinical, diagnostic, research or teaching laboratories involving moderate risk agents associated with human disease of varying severity. The primary hazards to lab personnel include accidental skin or mucous membrane exposures, or ingestion of infectious materials. BL 2 is appropriate when work is done with any human-derived blood, body fluids or tissues where the presence of an infectious agent may be unknown. Primary barriers recommended include BSCs and PPE. Secondary barriers recommended include waste decontamination facilities.

3. Biosafety Level 3

BL 3 practices, safety equipment and facilities are recommended for clinical, diagnostic, research or teaching laboratories involving indigenous or exotic agents that have a potential for respiratory transmission and that may cause serious and potentially lethal infection. Primary hazards to lab personnel include auto-inoculation, ingestion and exposure to infectious aerosols. Primary barriers recommended include BSCs or other enclosed equipment.

Secondary barriers include controlled access to the laboratory, a specialized ventilation system and waste decontamination facilities.

4. Biosafety Level 4

BL 4 represents maximum containment and is required for dangerous and exotic agents for which there is no available vaccine or therapy. These agents pose a high risk of life-threatening disease and may be transmitted through an aerosol route.

VI. Radiation safety

In addition to chemical and biological hazards, many laboratories also work with radioactive isotopes. Radiation safety is not covered in this manual. Refer to UTSA's Radiation Safety Manual or contact the Radiation Safety Officer at OSP for safety information and training schedules.

VII. Laboratory equipment

A general understanding of laboratory equipment and how it works is essential to working safely in the laboratory.

A. Chemical fume hood

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

Follow these guidelines for proper hood use:

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

B. Perchloric acid hood

Perchloric acid is a highly reactive, dangerous chemical. Its use inside a fume hood results in the deposition of perchloric acid precipitates that are potentially explosive. All work involving perchloric acid must be performed in an appropriate perchloric acid fume hood equipped with a wash-down system in the duct work to avoid precipitate

buildup. Since perchloric acid reacts violently with other chemicals—such as organic materials or dehydrating agent—the perchloric acid hood must be washed down after each use and dedicated only to work involving perchloric acid. These hoods should be marked “perchloric acid hood.”

C. Radioisotope fume hood

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

D. Biological safety cabinets

Biological safety cabinets (BSCs) are among the most effective and most commonly used primary containment devices in laboratories working with infectious agents. The BSC is designed to capture and contain infectious particulates or aerosols generated within the BSC and exhaust them through a HEPA filter. Since HEPA filters are ineffective against gaseous chemicals, volatile chemicals should not be used in BSCs; most BSCs recirculate a percentage of the exhausted air. There are three general types of BSCs: Class I, II and III.

1. Class I BSCs

These offer HEPA-filtered exhaust air; however, the supply air is not HEPA-filtered, thus offering minimal protection to the user's hands and arms and vulnerable research materials inside the BSC. The Class I BSC is designed for general microbiological research with low- and moderate-risk agents (biosafety level 1 and 2 agents) and is useful for the containment of mixers, blenders and other equipment.

2. Class II BSCs

There are different types of Class II BSCs, but they all offer HEPA-filtered supply and exhaust air. This BSC protects the user, environment and research material and is suitable for work with moderate- to high-risk agents (biosafety level 2 and 3 agents). Class II BSCs are the most commonly used.

3. Class III BSCs

Often referred to as “gloveboxes,” these gas-tight BSCs are under negative pressure. All work in the cabinet is done in rubber gloves attached to entry portals. Class III BSCs offer the highest level of protection and are suitable for work with extremely high risk agents (biosafety level 4).

The same guidelines for proper chemical fume hood use apply to BSCs and should be practiced to obtain maximum containment and protection. BSCs must be certified annually and whenever they are installed or moved or a filter is replaced. Visual inspection stickers must be posted on each BSC to inform users that the system has been tested.

E. Compressed Gas Cylinders

Compressed gas cylinders can present a dual hazard in the laboratory because the contents are under pressure and may contain hazardous materials.

Follow these guidelines for proper use of compressed gas cylinders:

1. Compressed gas cylinders, empty or full, must be chained in place or otherwise secured at all times.
2. Cylinder caps must be in place except when the cylinder is in use.
3. Do not transport gas cylinders without the cylinder cap in place and an appropriate dolly with a securing strap.
4. Cylinder and delivery valves should be closed when not in use (especially true for poisonous, flammable or corrosive gases).

F. Centrifuges

Improper centrifuge use can result in the generation and release of hazardous aerosols. Follow these guidelines for proper centrifuge use:

1. Make sure the lid is on and secured before operating the centrifuge.
2. Always balance the load in the centrifuge. If you are not filling the entire centrifuge rack, position the tubes opposite one another. If you have an odd number of samples, use an empty tube with enough water to equal the weight.
3. If vibration occurs, stop the centrifuge and check the load balances. Never operate an unbalanced centrifuge; this could result in breaking the centrifuge tube(s) and generating hazardous aerosols.
4. Keep the rotors and buckets clean, and promptly clean breakages or spills.

G. Refrigerators

Follow these guidelines for proper laboratory refrigerator use:

1. Flammable liquids must be stored in explosion-proof refrigerators.
2. Refrigerators must be labeled prominently to indicate whether they are suitable for storage of flammable liquids.
3. Never place food or beverages in a refrigerator where chemicals or biohazardous materials are stored.
4. Refrigerators containing biohazardous materials must be labeled "biohazardous." The biohazardous agent must be identified on the label.

H. Glassware

Follow these guidelines for proper laboratory glassware use:

1. Inspect all glassware before use. Discard broken, cracked or chipped glassware.
2. Fire-polish all cut-glass tubing and rods before use.
3. When inserting glass tubes or rods into stoppers, be sure the diameter of the tube is compatible with the diameter of the stopper; lubricate the glass with water or glycerol; and wear heavy gloves and insert the glass tube carefully with a twisting motion.
4. Dispose of broken glassware in an appropriate "broken glass" container, not the ordinary trash.

VIII. Emergency procedures and equipment

Due to the multiple hazards associated with laboratories, incidents are inevitable. Preparedness for emergencies is essential. A timely and efficient response can help minimize or avoid injury and damage to property. For a comprehensive discussion of UTSA emergency procedures, including internal (fire, bomb threat) and external (tornado, flooding) emergencies, see UTSA's emergency guidelines.

A. Chemical and biological spills

Response to chemical and biological spills must be thorough and prompt to prevent further injury or contamination. Each lab should design its own response plan based on its unique hazards and the location of the laboratory, in conjunction with the following general guidelines:

1. Notify the people in the immediate area and, if necessary, evacuate the lab. The decision to evacuate is a judgment call based on the properties and hazards of the spilled chemical or biological agent. If toxic or noxious gases or vapors or biological aerosols result from the spill, evacuation should follow. Contact Physical Plant Operations immediately; tell them to shut off air handlers to prevent the spread of toxic vapors or hazardous aerosols. If flammable gases or vapors result from the spill, turn off all sources of ignition in the lab.
2. Always attend to injured people before attending to the spill. Skin areas splashed by chemicals should be rinsed with water for at least 15 minutes in a sink, emergency shower or eyewash as appropriate. After thorough rinsing, seek medical help. Be sure to have the identity and other information—preferably the MSDS—about the chemical available for the medical help.
3. Try to contain the spill to keep it from spreading. Contact OSP to advise or assist in the containment, neutralization, disinfection and cleanup of the spilled chemical or biological agent. Do not attempt to clean the spill without proper spill-control supplies or equipment.
4. If the spill or release is likely to affect other facilities within the building or campus, contact the UTSA Police Department.

B. Emergency equipment

Laboratory emergency equipment includes emergency showers, eyewashes and fire extinguishers. Staff in labs that do not have their own emergency shower and eyewash station should know where the closest one is located. For information on the types of fire extinguishers and their uses, refer to UTSA's emergency guidelines.

1. Showers

An emergency shower can be used to suppress a fire or, more commonly, to decontaminate someone who has been exposed to chemicals.

1. Remove clothing, jewelry and shoes while standing under the shower. These items trap chemicals against the skin and will increase the damage if not removed.
2. Remain under the shower for at least 15 minutes to ensure adequate flushing of exposed areas.
3. Seek medical attention.
4. If the shower does not have a drain, promptly clean up the water to prevent slip hazards.
5. Always keep the area under an emergency shower unobstructed.

2. Eyewashes

1. If chemicals are splashed into your eyes, hold your eyelids open and flush with water continuously for at least 15 minutes. Move the eye up and down and sideways to wash thoroughly behind the eyeball where chemicals could be trapped.
2. Seek medical attention.
3. Always flush your eyes immediately if chemicals are splashed into them. Even a delay of a few seconds could cause permanent damage.
4. Continuous-flow eyewashes are preferred over the portable, squeeze-bottle type, whose disadvantages include an insufficient supply of water (not 15 minutes' worth) and easy contamination with microorganisms. Squeeze-bottle eyewashes also require the use of your hands to operate, preventing you from holding your eyelids open.
5. To ensure a clean supply of water in the eyewash, operate it weekly to flush out any impurities.

IX. Waste management

The Resource Conservation and Recovery Act of 1976 (RCRA) and subsequent amendments were passed by Congress to provide the legislative basis for hazardous waste management in the United States. The Environmental Protection Agency (EPA) is the federal agency responsible for the administration and enforcement of RCRA. In Texas, the EPA has delegated authority for administering and enforcing RCRA regulations to the Texas Natural Resource Conservation Commission (TNRCC). EPA and TNRCC hazardous waste regulations are designed to provide for the protection of public health and the environment through stringent requirements for generators, transporters and processors of hazardous waste. While RCRA's major focus is the management of hazardous waste from the point of generation to the point of disposal—referred to as “cradle to grave”—it also covers solid waste management in general and encourages recycling and alternative energy sources.

A. Hazardous waste

RCRA defines hazardous waste as a solid waste that is either characteristic or listed.

1. Characteristic waste

The EPA has identified four characteristics for hazardous wastes: ignitability, corrosivity, reactivity and toxicity.

Ignitability

- liquids having a flash point below 140°F
- solids that, under STP, may cause fire through friction, absorption of moisture or spontaneous chemical changes
- certain ignitable compressed gases
- oxidizers

Corrosivity

Any aqueous solution with a pH of less than or equal to 2 or greater than or equal to 12.5 or any liquid that will corrode steel faster than one-quarter inch per year. City of San Antonio codes are more stringent: the introduction of waste with a pH less than 5.5 or greater than 10.5 to the sanitary sewer is prohibited.

Reactivity

- normally unstable and readily undergoes violent change without detonating
- reacts violently or forms potentially explosive mixtures with water
- generates toxic gases, vapors or fumes when mixed with water
- cyanide- or sulfide-bearing waste that can generate toxic gases, vapors or fumes when exposed to a pH between 2 and 12.5
- capable of detonation or explosive reaction if subjected to a strong initiating source or heated under confinement
- readily capable of detonation or explosive decomposition or reaction at STP

Toxicity

A solid waste whose leachate (extract) contains any of the toxic heavy metals, pesticides or organics on the Toxicity Characteristic Constituents list (see Appendix IV) in concentrations equal to or greater than the regulatory levels. Solid waste exhibiting one or more of these characteristics is hazardous and subject to RCRA regulation.

2. Listed waste.

The EPA has designated hazardous waste to be any solid waste that is listed in one of four lists.

“F” list. Generic wastes from nonspecific sources. Wastes on this list include spent halogenated and nonhalogenated solvents.

“K” list. Specific wastes from specifically identified industries (sources). This list does not apply to UTSA.

“P” and “U” lists. Discarded commercial chemicals, including unused laboratory chemicals. “P”-listed wastes are acute hazardous waste, and “U”-listed wastes are toxic waste. See Appendix IV for the “P” and “U” hazardous waste lists.

B. Special waste

Many laboratory chemicals at UTSA are known to be toxic or otherwise hazardous but are not characteristic or listed and therefore are not RCRA hazardous wastes. Examples: ethidium bromide and spent formaldehyde solutions. The TNRCC recognized this and developed a waste category for these special wastes. A special waste is any solid waste that is not regulated as hazardous but, because of its quantity, concentration, physical and/or chemical characteristics or its biological properties, requires special handling and disposal to protect human health and the environment.

The following are considered special waste:

1. Biological and medical waste, including research animal tissues or carcasses, cultures and sharps (razor blades, syringe needles)
2. Waste whose toxic constituent concentration falls below the regulatory limits for the toxicity characteristic
3. Petroleum products, including oil and oil filters
4. Empty hazardous chemical containers
5. Light ballasts and small capacitors containing PCBs
6. Asbestos (friable)
7. Lead acid and nickel/cadmium (NiCad) batteries

C. Waste management guidelines

To avoid unnecessary handling and costs and to comply with federal and state regulations, UTSA labs must follow these guidelines:

1. Never discard hazardous or special waste into the trash or down the drain. These wastes must be collected for proper disposal. See Appendix V for San Antonio Water System drain discharge prohibitions.

2. Do not mix organic and aqueous waste in the same waste container. Water decreases the BTU value of flammable organic solvents and reduces its usability as a fuel.
3. Do not mix halogenated organic solvent waste with nonhalogenated organic solvent waste. Most halogenated organic solvents are persistent environmental hazards that are expensive to dispose of. They should be kept separate from other wastes.
4. Do not accumulate large volumes of waste before requesting a pickup. Small, frequent pickups are preferred.
5. Evaporation of solvents, especially chlorofluorocarbons (CFCs), for the purpose of disposal is not permitted.
6. Neutralization of acid and bases waste should not be performed by inexperienced laboratory personnel; instead, contact OSP for disposal. If neutralizations are performed in the lab by experienced personnel, be sure that there are no other hazardous constituents in the wastes and that neutralization is complete before disposing the waste down the drain.
7. Do not discard the following in the trash: empty chemical containers that contained acids, bases, solvents or any "P-" or "U-" listed chemicals (see Appendix IV). These are special wastes and must be rendered unusable before disposal. Laboratory staff should not attempt to do this; instead, contact OSP for disposal.
8. Spent lubricating oils must be collected for recycling purposes; do not contaminate them with any other wastes.
9. Do not mix or contaminate hazardous waste with radioactive waste. These wastes should be stored in separate locations in the lab.
10. Prevent unknowns by keeping all waste containers labeled. The burden of identifying unknowns lies with the laboratory generating the unknown and not OSP. Wastes generally will not be accepted if the contents are not known.
11. Do not accumulate waste in containers greater than five gallons, and do not fill the waste containers entirely; leave a little space at the top so the contents can be transferred without spillage.

D. Disposal procedures

OSP provides hazardous and special waste pickup and disposal services for UTSA. These services are free. We ask, however, that you follow these guidelines to ensure compliance with federal and state laws and to avoid unnecessary handling and costs.

1. Hazardous waste

1. Fill out a Hazardous Waste Disposal Form for each container of waste (see Appendix VI). Print legibly, identify all chemicals in the waste, including water (unknowns are not acceptable), and include the approximate volume and/or concentration of each chemical in the waste.
2. Attach the completed form to each container of waste. Each hazardous waste container requires a disposal form even if you have multiple containers of the same wastes. Place all waste containers for pickup together in a conspicuous location in the lab. Do not place any chemical wastes in the hallways.
3. Call OSP to request a waste pickup. Fridays are pickup days, although exceptions are made for emergencies.

2. Special waste

1. Hazardous Waste Disposal Forms are not required for special waste; however, special waste containers must be labeled in some other way to identify their contents.
2. All biological waste suspected or known to contain human or animal pathogens must be decontaminated before disposal.

3. Sharps must be collected in rigid, puncture-proof sharps containers (provided by OSP).
4. Animal carcasses must be kept frozen in designated freezers until pickup.
5. Call OSP to request a waste pickup. Special wastes will be picked up along with hazardous waste on Fridays.

E. Pollution prevention

The Waste Reduction Policy Act of 1991 requires generators of hazardous waste to develop a source reduction and waste minimization (SR/WM) plan and to report annually to the TNRCC. UTSA has a SR/WM plan in place and is overseen by OSP. Compliance with the plan is a joint effort between OSP and hazardous waste generators.

The Pollution Prevention Act of 1990 establishes a pollution prevention hierarchy in which source reduction is the best management option, followed by recycling, treatment and/or disposal.

Follow these source reduction and waste minimization guidelines in the laboratory:

1. Minimize mixing hazardous waste with nonhazardous waste, such as water. Do not dilute hazardous waste; this not only increases the volume necessary for disposal but may also affect any reusable properties of the waste, such as BTU value. The only exception is adding water to explosive chemicals to keep them wet.
2. Segregate your waste according to these waste streams: nonhalogenated organic solvent waste (no water); halogenated organic solvent waste (no water); photo fixer waste, aqueous waste with nonhalogenated organic solvents, aqueous waste with halogenated organic solvents, aqueous waste with toxic heavy metals, metallic mercury waste, lubricating oil, formalin, and ethidium bromide.
3. Avoid contamination of stock chemicals. Unused portions of a chemical should not be returned to the original container. To avoid removing too much, estimate how much of a chemical will be needed for an experiment. In teaching labs, preweigh chemicals for undergraduate usage.
4. Substitute less hazardous chemicals in experiments whenever possible.
5. Use spirit-filled instead of mercury-filled thermometers.
6. If a small amount of a chemical is needed, see whether other labs can provide it before placing an order.
7. Avoid buying chemicals in bulk. The cost of disposal usually outweighs the savings obtained by buying in bulk.
8. Participate in UTSA's ChemSwap chemical exchange program. Chemicals in this program are usually unopened and relatively new and are thus still usable. These chemicals are free to lab personnel.

References

1. Chapter 502 of the Health and Safety Code. Texas Hazard Communication Act, Revised 1993. Texas Department of Health, Division of Occupational Health, Hazard Communication Branch.
2. *Handbook of Laboratory Safety*. Chemical Rubber Company, Third Edition, 1990.
3. *Working Safely with Chemicals in the Laboratory*. Genium Publishing, Second Edition, 1994.
4. *Hazardous Chemicals in the Laboratory: A Guide for their Safe Use and Disposal*. The University of Texas Southwestern Medical Center at Dallas, Office of Environmental Health and Safety, 1994.
5. *Laboratory Safety Manual*. The University of Texas at Austin, Office of Environmental Health and Safety, Hazardous Materials Division, 1995.
6. *Biosafety in Microbiological and Biomedical Laboratories*. The Centers for Disease Control and Prevention and the National Institutes of Health, Third Edition, 1993.
7. *Biological Safety in the Laboratory: A Guide for Biological Safety and Handling Biological Agents*. The University of Texas Health Science Center at San Antonio, Department of Institutional Safety, 1995.

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Appendix I.

NOTICE TO EMPLOYEES

The Texas Hazard Communication Act (revised 1993), codified as Chapter 502 of the Texas Health and Safety Code, requires public employers to provide employees with specific information on the hazards of chemicals they may be exposed to in the workplace. As required by law, your employer must provide you with information and training. A brief summary of the law follows.

HAZARDOUS CHEMICALS

Hazardous chemicals are any products or materials that present any physical or health hazards when used, unless they are exempted under the law. Some examples of more commonly used hazardous chemicals are fuels, cleaning products, solvents, many types of oils, compressed gases, many types of paints, pesticides, herbicides, refrigerants, laboratory chemicals, cement and welding rods.

WORKPLACE CHEMICAL LIST

Employers must develop a list of hazardous chemicals used or stored in the workplace in excess of 55 gallons or 500 pounds. This list shall be updated by the employer as necessary, but at least annually, and it shall be made available for employees and their representatives on request.

EMPLOYEE EDUCATION PROGRAM

Employers shall provide training to newly signed employees before the employees work in a work area containing a hazardous material. Covered employees shall receive training from the employer on the hazards of the chemicals and on measures they can take to protect themselves from those hazards. This training shall be provided as needed, but at least whenever new hazards are introduced into the workplace or new information is received on the chemicals that are already present.

MATERIAL SAFETY DATA SHEETS

Employees who may be exposed to hazardous chemicals shall be informed of the exposure by the employer and shall have ready access to the most current material safety data sheets (MSDSs), which detail physical and health hazards and other pertinent information on those chemicals.

LABELS

Employees shall not be required to work with hazardous chemicals from unlabeled containers, except portable containers for immediate use, the contents of which are known to the user.

EMPLOYEE RIGHTS

Employees have rights to

- access copies of material safety data sheets
- information on their chemical exposures
- receive training on chemical hazards
- receive appropriate protective equipment
- file complaints, assist inspectors or testify against their employer

Employees may not be discharged or discriminated against in any manner for the exercise of any rights provided by this act. A waiver of employee rights is void; an employer's request for such a waiver is a violation of the act. Employees may file complaints with the Texas Department of Health at the toll-free number provided below.

EMPLOYERS MAY BE SUBJECT TO ADMINISTRATIVE PENALTIES AND CIVIL OR CRIMINAL FINES RANGING FROM \$50 TO \$100,000 FOR EACH VIOLATION OF THIS ACT.

Further information may be obtained from

Texas Department of Health
Toxic Substances Control Division
Hazard Communication Branch
1100 West 49th Street
Austin, Texas 78756

(800) 452-2791
(512) 834-6600
(512) 834-6644 fax

Appendix II. Chemical carcinogens regulated by OSHA

Vinyl chloride

2-Acetylaminofluorene

Acrylonitrile

4-Aminodiphenyl

Arsenic, inorganic

Asbestos

Benzene

Benzidine

Bis-chloromethyl ether

Cadmium

Coal tar pitch volatiles

1,2-Dibromo-3-chloropropane

3,3'-Dichlorobenzidine

4-Dimethylaminoazobenzene

Ethyleneimine

Ethylene oxide

Formaldehyde

Lead

Methyl chloromethyl ether

Methylenedianiline

a-Naphthylamine

b-Naphthylamine

4-Nitrobiphenyl

N-Nitrosodimethylamine

b-Propiolactone

This list of carcinogens is only one of many available lists of confirmed and suspected human carcinogens. Contact OSP to see any of the lists of carcinogens published by the following agencies and organizations:

American Conference of Governmental Industrial Hygienists (ACGIH)

International Agency for Research on Cancer (IARC)

National Institutes of Occupational Safety and Health (NIOSH)

National Toxicology Program (NTP)

Appendix III. Classification of infectious agents on the basis of hazard

Class 1 agents

All bacterial, parasitic, fungal, viral, rickettsial and chlamydial agents not included in higher classes.

Class 2 agents

Bacterial agents

Acinetobacter calcoaceticus

Actinobacillus-spp.

Aeromonas hydrophila

Arizona hinshawii-all serotypes

Bacillus anthracis

Bordetella-spp.

Borrelia recurrentis, *B. vincentii*

Campylobacter fetus

Campylobacter jejuni

Chlamydia psittaci

Chlamydia trachomatis

Clostridium botulinum

Cl. chuvoei, *Cl. haemolyticum*, *Cl. histolyticum*,

Cl. novyi, *Cl. septicum*, *Cl. tetani*

Corynebacterium diphtheriae, *C. equi*,

C. haemolyticum, *C. pseudotuberculosis*,

C. pyogenes, *C. renale*

Edwardsiella tarda

Erysipelothrix insidiosa

Escherichia coli—all enteropathogenic, entero-toxigenic, enteroinvasive and strains bearing K1 antigen

Haemophilus ducreyi, *H. influenzae*

Klebsiella-spp. and serotypes

Legionella pneumophila

Leptospira interrogans-spp.

Listeria-spp.

Moraxella-spp.

Mycobacterium-spp. (except those listed in Class 3)

Mycoplasma-spp. (except Mycoplasma mycoides and M. agalactiae, which are forbidden)

Neisseria gonorrhoea, N. meningitides

Nocardia-spp.

Pasteurella-spp. (except those listed in Class 3)

Salmonella-spp. and all serotypes

Shigella-spp. and all serotypes

Sphaerophorus necrophorus

Staphylococcus aureus

Streptobacillus moniliformis

Streptococcus pneumoniae, S. pyogenes

Treponema crateum, T. pallidum, T. pertenue

Vibrio cholerae, V. parahaemolyticus

Yersinia enterocolitica

Fungal agents

Actinomycetales (including Actinomyces spp. and Arachnia propionica)

Blastomyces dermatitidis

Cryptococcus neoformans

Paracoccidioides brasiliensis

Parasitic agents

Entamoeba histolytica

Leishmania-spp.

Naegleria gruberi, N. fowleri

Schistosoma mansoni

Toxoplasma gondii

Toxocara canis

Trichinella spiralis

Trypanosoma cruzi

Viral, rickettsial and chlamydial agents

Adenoviruses, human—all types
Cache Valley virus
Corona viruses
Coxsackie A and B viruses
Cytomegaloviruses
Echoviruses—all types
Encephalomyocarditis virus (EMC)
Flanders virus
Hart Park virus
Hepatitis-associated antigen material
Herpesvirus-associated antigen material
Herpesviruses (except Herpesvirus simiae—Monkey B virus—which is Class 4)
hTLV I/II
Human Immunodeficiency virus (except large volumes or high concentrations that require BL 3)
Influenza viruses—all types except A/PR8/34, which is Class 1
Langat virus
Measles virus
Mumps virus
Parainfluenza viruses—all types except
Parainfluenza virus 4, SF 4 strain, which is Class 1
Polio viruses—all types, wild and attenuated
Pox viruses—all types, except Alastrim, Smallpox and Whitepox, which are forbidden; and Monkey pox, which, depending on the experiment, is Class 3 or 4
Rabies virus—all strains except Rabies street virus, which is Class 3 or 4
Reoviruses—all types
Respiratory syncytial virus
Rhinoviruses—all types
Rochalimaea vinsonii
Rubella virus
Simian viruses—all types except Herpesvirus simiae (Monkey B virus) and Marburg virus, which are Class 4
Sindbis virus
Tensaw virus

Turlock virus
Vaccinia virus
Varicella virus
Vesicular stomatitis virus
Yellow fever virus, 17d vaccine strain

Class 3 agents

Bacterial agents
Bartonella-spp.
Brucella-spp.
Francisella tularensis
Mycobacterium avium complex, M. bovis, M. tuberculosis
Pasteurella multocida type B (“buffalo” and other foreign virulent strains)
Yersinia pestis

Fungal agents

Coccidioides immitis
Histoplasma capsulatum
Histoplasma capsulatum var duboisii

Parasitic agents

None

Viral, rickettsial, and chlamydial agents

Arboviruses—all strains except those in Class 2 and 4
Coxiella burnettii
Ehrlichia-spp.
Lymphocytic choriomeningitis virus (LMC)
Monkey pox virus, when used in vitro
Rabies street virus
Rickettsia-spp. (except R. ruminantium)
WestNile and Semliki Forrest viruses, depending on conditions of use and geographical location of the laboratory
Yellow fever virus, wild, when used in vitro

Class 4 agents

Bacterial, fungal and parasitic agents

None

Viral, rickettsial and chlamydial agents

Ebola fever virus

Hemorrhagic fever agents, including Crimean hemorrhagic fever, Congo, Junin and Machupo viruses

Herpesvirus simiae (Monkey B virus)

Lassa fever virus (*Mastomys natalensis*)

Marburg virus (*Cercopithecus* spp.)

Monkey pox, when used for transmission or animal inoculation experiments

Tick-borne encephalitis virus complex, including Russian spring-summer encephalitis, Kyasanur forest disease, Omsk hemorrhagic fever and Central European encephalitis viruses

Venezuelan equine encephalitis virus—epidemic strains, when used for transmission or animal inoculation experiments

Yellow fever virus—wild, when used for transmission or animal inoculation experiments

Low-risk oncogenic viruses

AD7-SV40

Adenovirus

Avian leukosis

Bovine leukemia

Bovine papilloma

CELO

Dog sarcoma

Guinea pig herpes

Hamster leukemia

HTLV I/II

Lucke (frog)

Marek's

Mason-Pfizer monkey virus

Mouse mammary tumor

Murine leukemia

Murine sarcoma

Polyoma

Rat leukemia

Rat mammary tumor

Rous sarcoma

Shope fibroma

Shope papilloma

SV-40

Moderate-risk oncogenic viruses

Ad2-SV40

EBV

FeLV

FeSV

GaLV

HV Ateles

HV Saimiri

SSV-1

Yaba

Appendix IV. RCRA hazardous waste

Toxicity characteristic constituents and regulatory levels

Constituent	Regulatory level (mg/L)		
		2,4,6-Trichlorophenol	2.0
Arsenic	5.0	2,4,5-TP (Silvex)	1.0
Barium	100.0	Vinyl chloride	0.2
Benzene	0.5		
Cadmium	1.0		
Carbon tetrachloride	0.5		
Chlordane	0.03		
Chlorobenzene	100.0		
Chloroform	6.0		
Chromium	5.0		
Cresols (including p,m,o isomers)	200.0		
2,4-D	10.0		
1,4-Dichlorobenzene	7.5		
1,2-Dichloroethane	0.5		
1,1-Dichloroethylene	0.7		
2,4-Dinitrotoluene	0.13		
Endrin	0.02		
Heptachlor (and its epoxide)	0.008		
Hexachlorobenzene	0.13		
Hexachlorobutadiene	0.5		
Hexachloroethane	3.0		
Lead	5.0		
Lindane	0.4		
Mercury	0.2		
Methoxychlor	10.0		
Methyl ethyl ketone	200.0		
Nitrobenzene	2.0		
Pentachlorophenol	100.0		
Pyridine	5.0		
Selenium	1.0		
Silver	5.0		
Tetrachloroethylene (perchloroethylene)	0.7		
Toxaphene	0.5		
Trichloroethylene	0.5		
2,4,5-Trichlorophenol	400.0		
		P list (acute hazardous waste)	
		chemical name	EPA number
		1-Acetyl--thiourea	P002
		Acrolein	P003
		Aldicarb	P070
		Aldrin	P004
		Allyl alcohol	P005
		Aluminum phosphide	P006
		5-(Aminomethyl)-3-isoxazolol	P007
		4-Aminopyridine	P008
		Ammonium picrate	P009
		Ammonium vanadate	P119
		Arsenic acid	P010
		Arsenic pentoxide	P011
		Arsenic trioxide	P012
		Benzcnehtiol	P014
		Benzyl chloride	P028
		Beryllium powder	P015
		Bromoacetone	P017
		Brucine	P018
		Carbon disulfide	P022
		Chloroacetaldehyde	P023
		p-Chloroaniline	P024
		1-(o-Chlorophenyl)thiourea	P026
		3-Chloropropionitrile	P027
		Cyanides (soluble salts)	P030
		Cyanogen	P031
		Cyanogen chloride	P033
		2-Cyclohexyl-4,6-dinitrophenol	P034
		Dichloromethyl ether	P016

Dichlorophenylarsine	P036	N-Nitrosomethylvinylamine	P084
Dieldrin	P037	Octamethylpyrophosphoramidate	P085
Diethylarsine	P038	Osmium tetroxide	P087
Diethyl p-nitrophenyl phosphate	P041	Parathion	P089
Diethyl o-pyrazinyl phosphorothioate	P040	Phenylmercury acetate	P092
Diisopropylfluorophosphate	P043	Phentlthiourea	P093
Dimethoate	P044	Phorate	P094
a,a-Dimethylphenethylamine	P046	Phosgene	P095
4,6-Dinitro-o-cresol, and salts	P047	Phosphine	P096
2,4-Dinitrophenol	P048	Propanenitrile	P101
Dinoseb	P020	Propargyl alcohol	P102
Disulfoton	P039	1,2-Propylenimine	P067
Dithiobiuret	P049	Selenourea	P103
Endosulfan	P050	Sodium azide	P105
Endothall	P088	Strontium sulfide	P107
Endrin	P051	Strychnine, and salts	P108
Epinephrine	P042	Tetraethyldithiopyrophosphate	P109
Ethyleneimine	P054	Tetraethyl lead	P110
Famphur	P097	Tetraethylpyrophosphate	P111
Fluorine	P056	Tetranitromethane	P112
Fluoroacetamide	P057	Thallium oxide	P113
Fluoroacetic acid, sodium salt	P058	Thallium(I) selenite	P114
Heptachlor	P059	Thallium(I) sulfate	P115
Hexaethyl tetraphosphate	P062	Thiofanox	P045
Isodrin	P060	Thiosemicarbazide	P116
Mercury fulminate	P065	Toxaphene	P123
Methomyl	P066	Trichloromethanethiol	P118
Methyl hydrazine	P068	Vanadium pentoxide	P120
Methyl isocyanate	P064	Warfarin, and salts	P001
2-Methylactonitrile	P069	Zinc phosphide (>10%)	P122
Methyl parathion	P071		
a-Naphthylthiourea	P072	U list (toxic hazardous waste)	
Nickel carbonyl	P073	chemical name	EPA number
Nicotine, and salts	P075	Acetaldehyde	U001
Nitric oxide	P076	Acetone	U002
p-Nitroaniline	P077	Acetonitrile	U003
Nitrogen dioxide	P078	Acetophenone	U004
Nitroglycerine	P081	2-Acetylaminofluorene	U005
N-Nitrosodimethylamine	P082	Acetyl chloride	U006

Acrylamide	U007	4-Chloro-o-toluidine, hydrochloride	U049
Acrylic acid	U008	Chrysene	U050
Acrylonitrile	U009	Creosote	U051
Amitrole	U011	Cresol	U052
Aniline	U012	Cumene	U055
Auramine	U014	Cyanogen bromide	U246
Azaserine	U015	Cyclohexane	U056
Benz[c]acridine	U016	Cyclohexanone	U057
Benzal chloride	U017	Cyclophosphamide	U058
Benz[a]anthracene	U018	Daunomycin	U059
Benzene	U019	DDD	U060
1,3-Benzenediol	U201	DDT	U061
Benzenesulfonic acid chloride	U020	Diallate	U062
Benzidine	U021	Dibenz[a,h]anthracene	U063
Benzo[a]pyrene	U022	Dibenzo [a,i]pyrene	U064
p-Benzoquinone	U197	1,2-Dibromo-3-chloropropane	U066
Benzotrichloride	U023	1,2-Dibromoethane	U067
2,2'-Bioxirane	U085	Dibromomethane	U068
Bromoform	U225	Dibutyl phthalate	U069
4-Bromophenyl phenyl ether	U030	o-Dichlorobenzene	U070
2-Butanone	U159	m-Dichlorobenzene	U071
2-Butenal	U053	p-Dichlorobenzene	U072
Butyl alcohol	U031	3,3'-Dichlorobenzidine	U073
Cacodylic acid	U136	1,4-Dichloro-2-butene	U074
Calcium chromate	U032	Dichlorodifluoromethane	U075
Carbonic difluoride	U033	1,1-Dichloroethane	U076
Carbon tetrachloride	U211	1,2-Dichloroethane	U077
Chlorambucil	U035	1,1-Dichloroethylene	U078
Chlordane, a and y isomers	U036	1,2-Dichloroethylene	U079
Chlornaphazin	U026	Dichloroethyl ether	U025
Chlorobenzene	U037	Dichloroisopropyl ether	U027
Chlorobenzilate	U038	Dichloromethane	U080
p-Chloro-m-cresol	U039	Dichloromethoxy ethane	U024
Chloroethene	U043	2,4-Dichlorophenol	U081
2-Chloroethyl vinyl ether	U042	2,6-Dichlorophenol	U082
Chloroform	U044	2,4- Dichlorophenoxyacetic acid	U240
Chloromethyl methyl ether	U046	1,2-Dichloropropane	U083
2-Chloronaphthalene	U047	1,3-Dichloropropene	U084
o-Chlorophenol	U048	Diepoxybutane	U085

Diethylhexyl phthalate	U028	Formaldehyde	U122
N,N'-Diethylhydrazine	U086	Formic acid	U123
O,O-Diethyl S-methyl dithiophosphate	U087	Furan	U124
Diethyl phthalate	U088	Furfural	U125
Diethylstilbestrol	U089	Glycidylaldehyde	U126
Dihydrosafrole	U090	Hexachlorobenzene	U127
3,3'-Dimethoxybenzidine	U091	Hexachlorobutadiene	U128
Dimethylamine	U092	Hexachlorocyclopentadiene	U130
p-Dimethylaminoazobenzene	U093	Hexachloroethane	U131
7,12-Dimethylbenz[a]anthracene	U094	Hexachlorophene	U132
3,3'-Dimethylbenzidine	U095	Hexachloropropene	U243
a,a-Dimethylbenzyl-hydroperoxide	U096	Hydrazine	U133
Dimethylcarbamoyl chloride	U097	Hydrofluoric acid	U134
1,1-Dimethylhydrazine	U098	Hydrogen sulfide	U135
1,2-Dimethylhydrazine	U099	Indeno[1,2,3-cd]pyrene	U137
2,4-Dimethylphenol	U101	Iodomethane	U138
Dimethyl phthalate	U102	Isobutyl alcohol	U140
Dimethyl sulfate	U103	Isosafrole	U141
2,4-Dinitrotoluene	U105	Kepone	U142
2,6-Dinitrotoluene	U106	Lasiocarpine	U143
Di n-octyl phthalate	U107	Lead acetate	U144
1,4-Dioxane	U108	Lead phosphate	U145
1,2- Diphenyl hydrazine	U109	Lead subacetate	U146
Dipropylamine	U110	Lindane	U129
Di-n-propylnitrosamine	U111	Maleic anhydride	U147
Epichlorohydrin	U041	Maleic hydrazide	U148
2-Ethoxyethanol	U359	Malononitrile	U149
Ethyl acetate	U112	Melphalan	U150
Ethyl acrylate	U113	Mercury	U151
Ethyl carbamate	U238	Methacrylonitrile	U152
Ethylenebisdithiocarbamic acid,		Methanethiol	U153
salts and esters	U114	Methanol	U154
Ethylene glycol monoethyl ether	U359	Methapyrilene	U155
Ethylene oxide	U115	Methoxychlor	U247
Ethylenethiourea	U116	Methyl bromide	U029
Ethyl ether	U117	Methyl chloride	U045
Ethyl methacrylate	U118	Methyl chlorocarbonate	U156
Ethyl methanesulfonate	U119	3 -Methyl chloranthrene	U157
Fluoranthene	U120	4,4'-Methylenebis(2-chloroaniline)	U158

Methyl ethyl ketone	U159	Saccharin, and salts	U202
Methyl ethyl ketone peroxide	U160	Safrole	U203
Methyl isobutyl ketone	U161	Selenious acid	U204
Methyl methacrylate	U162	Selenium sulfide	U205
N-Methyl -N'-n itro-N-nitrosoguani-	U163	Streptozotocin	U206
line			
Methylthiouracil	U164	1,2,4,5-Tetrachlorobenzene	U207
Mitomycin C	U010	1, 1, 1,2-Tetrachloroethane	U208
1-Naphthalenamine	U167	1,1,2,2-Tetrachloroethane	U209
2-Naphthalenamine	U168	Tetrachloroethylene	U210
Naphthalene	U165	Tetrahydrofuran	U213
1,4-Naphthalenedione	U166	Thallium(I) acetate	U214
Nitrobenzene	U169	Thallium(I) carbonate	U215
p-Nitrophenol	U170	Thallium(I) chloride	U216
2-Nitropropane	U171	Thallium(I) nitrate	U217
N-Nitrosodi-n-butylamine	U172	Thioacetamide	U218
N-Nitrosodiethanolamine	U173	Thiourea	U219
N-Nitrosodiethylamine	U174	Thiram	U244
N-Nitroso-N-ethylurea	U176	Toluene	U220
N-Nitroso-N-methylurea	U177	Toluenediamine	U221
N-Nitroso-N-methylurethane	U178	Toluene diisocyanate	U223
N-Nitrosopiperidine	U179	o-Toluidine	U328
N-Nitrosopyrrolidine	U180	p-Toluidine	U353
5-Nitro-o-toluidine	U181	o-Toluidine hydrochloride	U222
Paraldehyde	U182	Trichloroacetaldehyde	U034
Pentachlorobenzene	U183	1,1,1-Trichloroethane	U226
Pentachloroethane	U184	1, 1,2-Trichloroethane	U227
Pentachloronitrobenzene	U185	Trichloroethylene	U228
1,3-Pentadiene	U186	Trichlorofluoromethane	U121
Phenacetin	U187	1,3,5-Trinitrobenzene	U234
Phenol	U188	Tris(2,3-dibromopropyl) phosphate	U235
Phosphorus sulfide	U189	Trypan blue	U236
Phthalic anhydride	U190	Uracil mustard	U237
2-Picoline	U191	Vinyl chloride	U043
Pronamide	U192	Warfarin, and salts	U248
1,3-Propane sultone	U193	Xylenes	U239
n-Propylamine	U194	Zinc phosphide (< 10%)	U249
Pyridine	U196		
Reserpine	U200		
Resorcinol	U201		

Appendix V. San Antonio Water System discharge prohibitions

The following prohibitions are taken from City Ordinance 77784.

General prohibitions

The following general chemical categories are not permitted to be discarded down the drain:

explosives

flammables

toxics/poisons

aqueous with ph <5.5 or >10.5

petroleum products

radioactive materials

Specific prohibitions

The following chemicals in excess of the limits listed below are not permitted to be discarded down the drain. The regulatory level refers to total concentration, not leachate concentration.

Chemical	Regulatory level (mg/L)
Arsenic	0.07
Barium	5.0
Cadmium	8.0
Chromium	10.0
Copper	7.0
Cyanides	2.5
Lead	0.7
Manganese	1.0
Mercury	0.05
Nickel	5.5
Selenium	0.02
Silver	0.5
Zinc	4.0

Appendix VI.

Hazardous Waste Disposal Form

The University of Texas at San Antonio • 6900 N. Loop 1604 West • San Antonio, TX 78249-0672 • (210) 458-5250

- Must be filled out by responsible Generator
- Use only one form per container
- Print legibly
- Call Office of Occupational & Safety Programs (458-5250) for pick-up

OFFICE USE ONLY

Date picked up _____ By: _____

WS # _____ Drum # _____

Neutralization date _____

Generator/Name _____

Building/Room _____ **Phone** _____

Date Requested _____

Chemical Contents

Concentration/volume

Hazards

Chemical Contents	Concentration/volume	Hazards
_____	_____	<input type="checkbox"/> Flammable
_____	_____	<input type="checkbox"/> Corrosive
_____	_____	<input type="checkbox"/> Toxic
_____	_____	<input type="checkbox"/> Reactive
_____	_____	<input type="checkbox"/> _____
_____	_____	