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## **I N D E X**

# FOREWORD

The Environmental Health & Safety Office (EH&S) supports The University in its quest to excel in research and teaching. EH&S has prepared this manual to promote safe practices in laboratories. We hope it will provide information to faculty, researchers, and students to assist them in meeting their goals.

We have included information concerning safe practices, the use of personal protective equipment, emergency procedures, use and storage of chemicals, and the proper methods of waste disposal. This information is intended to help those in the laboratory minimize the hazards to themselves and their colleagues.

We promote the idea of providing information to laboratory personnel regarding the requirements under the Texas Hazard Communication Act. These requirements include chemical labeling, employee education, and access to Material Safety Data Sheets.

Even though the University does not currently fall under the jurisdiction of OSHA, we also provide information concerning the Bloodborne Pathogens Standard. Please contact our Hazardous Materials section at 272-2185 for more information.

# 1. Introduction

## A. ORGANIZATION

The Environmental Health & Safety Office (EH&S) maintains a Hazardous Materials Section devoted to chemical and biological safety in the laboratory, reporting directly to the Associate Director of EH&S.

## B. GOALS

The goals of the Hazardous Materials section include: 1) to facilitate The University of Texas at Arlington's regulatory compliance with all applicable local, state and federal waste management regulations by properly transporting, storing, and disposing of regulated wastes; 2) to facilitate the operations and waste minimization efforts of the various departments and divisions of The University while striving for regulatory compliance; 3) to train individuals and inspect work areas where hazardous materials are used.

## C. KEY RESPONSIBILITIES

All lab personnel (i.e., faculty, graduate students, post-docs, technicians) are responsible for following the University procedures as described in this manual. An outline follows which summarizes the key responsibilities which are discussed in more detail throughout this manual.

<b>Responsible Party</b>	<b>Required Action</b>
Lab Personnel	Meet labeling requirements of the Hazard Communication Act
EH&S	Inspect all labs where controlled substances or precursor chemicals are used
Lab Personnel	Perform self-audit (See Evaluation Form in APPENDIX X) of lab for health and safety conditions no less than once every six months
EH&S	Inspect 100% of all labs on an annual basis
Lab Personnel	Contact EH&S if fumehood is not working properly
EH&S	Test all fumehoods on an annual basis
Lab Personnel	Attend Laboratory Safety and Waste Management training
Department Heads and Faculty	Ensure that Faculty and graduate students properly dispose of or transfer all hazardous materials before leaving the University
EH&S	Participate as a member of the UT Arlington Chemical/Biological Safety Committee and perform inspections as required.
EH&S	Inspect labs using infectious agents in accordance with the CDC/NIH Guidelines

## **D. FACILITIES**

Facilities to which this manual applies include the Main Campus of The University of Texas at Arlington, the Automation Robotics Research Institute, and all of the University's remote sites.

## 2. Objectives

The objectives of the Hazardous Materials Section are to:

- A. Comply with regulatory requirements under its control, including: transportation of waste from its users to the EH&S accumulation facilities, storage of wastes, and shipment of wastes for disposal,
- B. Inspect all fumehoods at least one time each year,
- C. Inspect all areas generating regulated waste for compliance with applicable regulations at least two times each year,
- D. Inspect 10% of all laboratories and other associated areas using hazardous materials (biological and chemical) for safe laboratory practices each year,
- E. Inspect all laboratories known to EH&S to be purchasing controlled substances or precursor chemicals for proper controls one time each year,
- F. Make waste determinations within two working days from the date of receipt of a properly completed Hazardous Chemical Waste Form and remove all regulated wastes from the site of generation within three working days from the date of making the waste determination,
- G. Provide training for all new employees working with hazardous materials (biological and chemical) as well as refresher training as needed for all existing employees.

# 3. General Safety Information

## A. Lab Protocol

Everyone in the lab is responsible for his or her own safety and for the safety of others. Before starting any work in the lab, become familiar with the procedures, equipment, and chemicals that are to be used. If you don't understand something, ask! The following guidelines are recommended for working safely in a lab:

### Personal Practices

1. Never wear shorts, sandals, or open-toed shoes in the lab.
2. Do not allow children or pets in laboratories.
3. Never pipette anything by mouth.
4. Be aware of dangling jewelry, loose clothing, or long hair that might get caught in equipment.
5. Designate non-lab areas for eating and drinking. Remember, smoking is not allowed in any University building.
6. Store food and drinks in refrigerators that are designated for that use only.
7. Do not wear lab coats, gloves, or other personal protective clothing out of the lab and into non-lab areas. This clothing may have become contaminated and you could spread the contamination.
8. Never work alone in a lab if it is avoidable. If you must work alone, make someone aware of your location and have them call or check on you periodically.
9. Wash your hands frequently throughout the day and before leaving the lab.
10. Contact lenses should not be worn in a lab because chemicals or particulates can get caught behind them and cause severe damage to the eye.

### Housekeeping

1. Clean your work area throughout the day and before you leave at the end of the day.
2. If necessary, clean equipment after use to avoid the possibility of contaminating the next person who needs to use it.
3. Keep all aisles and walkways in the lab clear to provide a safe walking surface and an unobstructed exitway.



## B. Recommended Lab Techniques

This section deals with techniques, equipment, and procedures commonly found within a laboratory setting. It is beyond the scope of this manual to describe all techniques and equipment that may be used in a lab. For further information on this topic, refer to *Prudent Practices in the Laboratory*, which is published by the National Academy Press.

### Glassware

1. Inspect all glassware before use. Repair or discard any broken, cracked, or chipped glassware.
2. Tape or shield glass vacuum vessels to prevent flying glass in the case of an implosion. Also, tape or shield glass vacuum desiccators.
3. Do not use household Thermos bottles as a substitute for laboratory Dewar flasks; the walls are too thin.
4. Transport all glass chemical containers in rubber or polyethylene bottle carriers.
5. Fire-polish all cut glass tubing and rods before use.
6. Practice the following when inserting glass tubes or rods into stoppers:
  - a. The diameter of the tube must be compatible with the diameter of the stopper,
  - b. Fire-polish the end of the glass tube,
  - c. Lubricate the glass with water or glycerol,
  - d. Wear heavy gloves and hold the glass not more than two inches from the end to be inserted,
  - e. insert the glass carefully with a twisting motion, and
  - f. remove stuck tubes by slitting the stopper with a sharp knife.

### Assembling Apparatus

1. Keep work surfaces as uncluttered as possible.
2. Set up clean, dry apparatus, firmly clamped and back away from the edge of the lab bench.
3. Only use equipment that is free from cracks, chips, or other defects.
4. If possible, place a pan under a reaction vessel or other container to contain liquid if the glassware breaks.
5. Do not allow burners or any other ignition sources nearby when working with flammable liquids.
6. Lubricate glass stopcocks.

7. Properly support and secure condensers and water hoses with clamps and wires. Be sure to direct the water hoses so that any drips that may come off the hoses do not splash down onto any electrical wires.
8. Position apparatus that is attached to a ring stand with the center of gravity over the base and not to one side.
9. Assemble the apparatus so that burners or baths can be removed quickly.
10. Use an appropriate vapor trap and confine the setup to a fumehood if there is a possibility of hazardous vapors being evolved.
11. Put the setup in a fumehood whenever conducting a reaction that could result in an implosion or explosion. Keep the sash pulled down. If it is not possible to use a fumehood, use a standing shield that is stabilized and secured.
12. Always wear a lab coat and proper eye and face protection.

## Centrifuges

1. Securely anchor tabletop centrifuges and place them in a location where the vibration will not cause bottles to fall off the bench.
2. Keep the centrifuge lid closed while operating, and do not leave the centrifuge until you are certain it is running safely without vibration.
3. If the centrifuge starts vibrating, stop it, and check the load balances.
4. Regularly clean rotors and buckets with a non-corrosive cleaning solution.
5. Use sealed safety cups while centrifuging hazardous materials.

## Ultraviolet Lamps

1. Wear ultraviolet absorbing protective safety glasses while working with ultraviolet light.
2. Protect your skin from potential burns due to ultraviolet light.
3. Shield any experiment in which ultraviolet light is used in order to prevent escape of the direct beam or scattered radiation.

## Lasers

1. Always wear goggles that protect against the specific wavelength of the laser.

2. Never look directly at the beam.
3. Do not allow any reflective materials in or along the beam.
4. Post warning signs in all laser areas. If possible, use a flashing light at the lab entrance to indicate when a laser is in use.

## **Separatory Funnels**

1. Use extreme caution if the temperature of the materials is elevated.
2. When a volatile solvent is used, swirl the unstoppered separatory funnel first to allow some solvent to vaporize and to release pressure.
3. Close the funnel and invert it with the stopper held in place, then immediately open the stopcock to release pressure.
4. Do not vent the separatory funnel near a flame or any other ignition source and do not point it at a co-worker or equipment. It is best to vent the separatory funnel into a fumehood.
5. Close the stopcock, swirl the funnel, then immediately open the stopcock with the funnel in an inverted position to vent the vapors again.

## **Cooling Baths and Cold Traps**

1. Always use caution when working with cryogenic coolants.
2. Use temperature resistant gloves and a faceshield while slowly immersing an object to be cooled.
3. Do not pour cold liquid onto the edge of a glass Dewar flask when filling because the flask may break and implode.
4. Never lower your head into a dry ice chest; no oxygen is present.
5. Wear temperature resistant gloves while handling dry ice. If no protection is used, severe burns can result.

## **Vacuum Pumps**

1. If at all possible, vent vacuum pump exhaust into a fumehood.
2. Guard all belt-driven vacuum pumps to prevent hands or loose clothing from getting caught in the belt pulley.
3. Place a trap between the vacuum pump and the apparatus.

4. Lubricate pump regularly if possible, check belt conditions, do not operate in a fumehood cabinet that is used for storage of flammables.

## **Odors in the Lab**

At least once a month, pour one liter of water into all floor drains and sinks in the lab, including cup sinks on lab benches and in fumehoods. If the traps are allowed to dry out, odors present in the sanitary sewer system will come vent into the lab.

## **Electrical**

1. Examine all electrical cords periodically for signs of wear and damage. If damaged electrical cords are discovered, unplug the equipment and send it off for repair.
2. All equipment must be properly grounded.
3. If sparks are noticed while plugging or unplugging equipment or if the cord feels hot, do not use the equipment until it can be serviced by an electrician.
4. Do not run electrical cords along the floor where they will be a tripping hazard and be subject to wear. If a cord must be run along the floor, protect it with a cord cover.
5. Do not run electrical cords above the ceiling. The cord must be visible at all times to ensure it is in good condition.
6. Do not plug too many items into a single outlet. Cords that enable you to plug more than one item in at a time should not be used. Multi-plug strips can be used if they are protected with a circuit breaker and if they are not over used.
7. Do not use extension cords for permanent wiring. If you must use extension cords throughout the lab, then it is time to have additional outlets installed.

## 4. Emergency Procedures and Equipment

The first step in responding to an emergency is to prepare for it in advance. In planning, be sure to consider all possible occurrences and their magnitude that can create or complicate an emergency situation, such as the following:

1. What are the potential spill locations? Can any locations be consolidated or moved to safer areas?
2. What materials might be spilled? Are any incompatible with each other?
3. What quantities may be involved in a spill? Are more materials being stored in the lab than are actually needed?
4. What are the hazardous properties of the materials?
5. What personal safety equipment might be needed? Is it available? Are personnel trained to use it properly? Is appropriate equipment available for all possible needs?

Supplies and equipment should be assembled and kept on hand to deal with any potential spills. The extent to which spill equipment is available depends on the chemicals, the process, and the personnel working in the lab. Assistance in obtaining chemical spill control kits is available from the Environmental Health and Safety's Hazardous Materials Section at 2185.

A list of telephone numbers should be posted near every entrance of each laboratory and storeroom and on every telephone. Telephone numbers should include the Laboratory Supervisor, UTA Police Department (3003), and the Environmental Health and Safety Office (EH&S) Hazardous Materials Section (2185). People calling should explain the situation clearly, calmly, and in detail.

Since each laboratory is unique in its use of hazardous materials and physical surroundings, the emergency procedures listed below may be used but should be tailored to particular needs. The best plan becomes useless if specific basic safety equipment and supplies are not readily available when needed. Equipment for unlikely contingencies should not be kept in labs because emergency responders can be called in these cases, but personnel should be trained on whom to call if they do occur. Trial runs should be made once procedures and equipment become available.

It is the responsibility of uninjured co-workers nearest to an accident to take immediate action. Trained personnel or an emergency team can continue procedures after the initial action by personnel in the vicinity.

### ***An emergency can be complicated by several problems:***

1. Failure of personnel to respond promptly to the emergency.
2. Failure of personnel to recognize the need to summon additional help.
3. Inadequately trained personnel taking the wrong actions in response to an emergency.

4. Personnel lacking information pertinent to the nature of the emergency that would substantially change the proper response to the emergency.
5. Personnel endangering themselves while attempting to rescue others.

## **A. PRIMARY EMERGENCY PROCEDURES**

Include the following steps:

1. Do not take any action unless you have been trained to respond, except to summon assistance.
2. Attend to any person(s) who may have been contaminated and/or injured if it is safe to reach them. Use safety showers and eyewashes as appropriate. Call the UTA Police Department at 3003 for assistance with injuries, fire, or for performing rescues. Give the nature and the extent of the emergency; be as specific and detailed as possible. An ambulance, fire truck or police vehicle will respond upon your request.
3. Notify persons in the immediate area about the spill, evacuating all non-essential personnel from the spill area and adjoining areas that may be impacted by vapor, a fire (even if not started yet), etc.
4. If the spilled material is flammable, turn off all potential ignition sources.
5. Notify the Environmental Health & Safety Office (2185).
6. Avoid breathing vapors of the spilled materials. Be aware that some materials either have no odors or anesthetize your nose so that you stop smelling the odor very quickly.
7. Leave on or establish exhaust ventilation if it is safe to do so. Close doors to slow down the spread of odors.
8. Obtain spill control kit appropriate to material spilled.
9. During cleanup, wear *appropriate* protective apparel. Be sure to verify appropriateness.
10. Cover liquid spills with compatible absorbent material such as spill pillows or a kitty litter, vermiculite mix. Be sure to check compatibility. Powdered materials should be covered with wet paper towels (if compatible) to avoid dispersal. If appropriate materials are available, corrosives should be neutralized prior to absorption. Clean spills from the outer areas first, cleaning towards the center.
11. Place the spilled material into an impervious container, seal, and contact EH&S for disposal.
12. Wash the affected surface with soap and water. Mop up the residues and containerize for disposal.
13. A solvent, e.g. xylene, may be necessary to clean surfaces contaminated with a non-water soluble chemical. Be sure to check the solubility of the spilled material and use the least dangerous effective solvent available. Be sure to wear appropriate protective equipment.

***The following are lists of special procedures for radioactive and biohazard spills:***

## **B. SPECIAL PROCEDURES FOR RADIOACTIVE HAZARDS**

1. Do not take any action unless you have been trained to respond, except to summon assistance.
2. Attend to any person(s) who may have been contaminated and/or injured if it is safe to reach them. Use safety showers and eyewashes as appropriate. Call the UTA Police Department at 3003 for assistance with injured, fire, or for performing rescues. Give the nature and the extent of the emergency; be as specific and detailed as possible. An ambulance, fire truck or police vehicle will respond upon your request.
3. Remove all personnel from immediate spill area to a safe meeting location in or near the lab.
4. Shut off ventilation, close windows and doors, turn off hoods if possible.
5. Notify Environmental Health & Safety Radiation Safety section (2185). Obtain appropriate radiation meters if available.
6. Under the direction of the EH&S Radiation Safety section, check all personnel for skin and clothing contamination.
7. Under the direction of the EH&S Radiation Safety section, decontaminate personnel and re-survey until radiation levels are at background.

## **C. SPECIAL PROCEDURES FOR BIOLOGICAL HAZARDS**

1. Do not take any action unless you have been trained to respond, except to summon assistance.
2. Attend to any person(s) who may have been contaminated and/or injured if it is safe to reach them. Use safety showers and eyewashes as appropriate. Call the UTA Police Department, 3003, for assistance with injuries, fire, or for performing rescues. Give the nature and the extent of the emergency; be as specific and detailed as possible. An ambulance, fire truck or police vehicle will respond upon your request.
3. If the room is equipped with ultraviolet lights, turn them on.
4. Leave the laboratory and close all doors.
5. Notify persons in the immediate area about the spill. Evacuate non-essential personnel from the spill area.
6. Notify the Environmental Health & Safety Office (2185).
7. If your clothing is contaminated, remove it and place it in a properly labeled impervious container. Avoid close contact with other people to prevent additional exposures. Take a shower.

8. Put on protective clothing and equipment.
9. Wait at least 30 minutes for the aerosol to settle before entering the contaminated room. Turn off ultraviolet lights and check for visible mists in the air before entering.
10. Apply appropriate disinfectant to the spill with a gentle flooding action to avoid secondary aerosols. Allow sufficient contact times.
11. Cover excess liquids with absorbent material. Dry material should be covered with wet paper towels to avoid dispersal.
12. Place the spill clean-up material into a container and autoclave it, or call EH&S for disposal.
13. Wash the affected surface with strong disinfectant.
14. For a spill in a biological safety cabinet: clean it immediately, keep the cabinet running, and use a chemical disinfectant such as bleach or alcohol and paper towels.
15. For a minimally hazardous material without aerosol, and in small volume: clean with paper towel soaked in a disinfectant.

**Note:** For additional information regarding biological spills refer to Emergency Procedures of the Biological Hazards and Control section of this manual.

## **D. BUILDING EVACUATION PROCEDURES**

1. Building evacuation may be necessary if there is a chemical release, fire, explosion, natural disaster, or medical emergency.
2. Be aware of the marked exits from your area and building.
3. The evacuation alarm is a loud continuous siren or horn.
4. To activate the building alarm system, pull the handle on one of the red boxes located in the hallway. If there is a fire, call 3003, give your name and describe the location and size of the fire.
5. *Whenever* the building evacuation alarm is sounded or when you are ordered to leave by the campus police, EH&S, or emergency response personnel, *walk quickly to the nearest marked exit* and ask others to do the same.
6. Outside, proceed to a clear area that is at least 150 feet from the affected building. Keep walkways clear for emergency vehicles.
7. To the best of your ability and without reentering the building, be available to assist EH&S and campus police in their attempts to determine that everyone has been evacuated safely.
8. An Emergency Command Post will be set up near the emergency site by the emergency responders. Keep clear of the Post unless you have important information to report.



9. Do not return to the building until you are told to do so by the campus police or EH&S.

## **E. EMERGENCY EQUIPMENT**

Know the location of your emergency shower, eyewash, and fire extinguisher! In the event of an emergency, you may not remember where this equipment is located. Also, eye injuries may require that you find your emergency equipment without being able to see. In addition, it is a good practice to mark the location of all emergency equipment with a prominent sign.

### **Showers**

1. An emergency shower can be used to suppress a fire or more commonly to decontaminate a person who has been exposed to chemicals.
2. Remove all clothing, jewelry, and shoes while standing under the shower. If these items are not removed, they will hold the chemicals against the skin and increase the damage. A fire blanket may be used as a modesty curtain for the person disrobing.
3. Remain under the shower for at least 15 minutes, then seek medical attention.
4. Always keep the area under an emergency shower unobstructed. You do not want to waste time moving boxes, tables, or other items. Electrical equipment in the area can also present an electrocution hazard.
5. Do not tie or secure the handle or ring of the shower if it will interfere with the operation of the shower.

**Note:** Be cautious, wet floors are (may be) slippery!

### **Eyewashes**

1. To ensure a clean supply of water in the eyewash, the eyewash should be operated weekly to flush any impurities that may have accumulated.
2. Never hesitate to flush your eyes immediately if chemicals are splashed in them. Even a delay of a few seconds could cause permanent damage.
3. If chemicals are splashed into the eye, hold the eyelids open and flush with water continuously for at least 15 minutes.
4. Move the eye up and down and sideways to wash thoroughly behind the eyeball where chemicals could be trapped.
5. Seek medical attention.
6. Continuous flow eyewashes are preferred over the portable type. The portable eyewashes have several disadvantages: insufficient supply of water, they readily become contaminated with microorganisms, and they require the use of your hands, which prevents you from holding the eyelids open.

**Note:** Emergency showers and eyewash fountains are inspected and tested annually by EH&S. If these items are not operating properly, contact EH&S at 2185.

## Fire Extinguishers

1. Most labs will be equipped with a carbon dioxide or an ABC dry chemical powder fire extinguisher. The ABC extinguisher can be used on a paper, chemical, or electrical fire. The carbon dioxide extinguisher can be used on a chemical or electrical fire and is the extinguisher of choice for electrical equipment. *Never use a water fire extinguisher on an electrical fire.* Only a Class D combustible metal fire extinguisher can be used on a metal (magnesium, sodium, potassium, etc.) fire. There are also commercially available materials that can be applied to a burning metal fire.
2. Attempt to extinguish small fires yourself, only if you have been trained, and always fight the fire from a position that allows escape.
3. To use a fire extinguisher, follow these four steps:
  - a. **P**ull the pin
  - b. **A**im the extinguisher nozzle at the base of the fire
  - c. **S**queeze the handle to release the extinguishing media
  - d. **S**weep the nozzle from side to side at the base of the fire starting at the front and working to the rear until it goes out
4. Remember the word **PASS** when using a fire extinguisher: Pull, Aim, Squeeze, and Sweep.
5. If you cannot extinguish the fire in approximately 30 seconds, evacuate the area, closing the door as you leave, and activate the fire alarm.
6. If a fire extinguisher is used at all, is found vandalized, or for any other reason is in need of service, call the EH&S Fire section at 2185 for immediate replacement.
7. For training, including fire prevention, evacuation, reporting, hands-on fire extinguisher use, and determining fire extinguisher needs in your work area, call the EH&S Fire section at 2185.

## Spill Equipment

1. Supplies for cleaning up a minor chemical or biological spill should be readily available.
2. Supplies for a chemical spill include: an inert absorbent such as kitty litter or vermiculite, a plastic (non-sparking) scoop, plastic bags to put the spilled material into, heavy gloves, goggles, and sodium bicarbonate to neutralize acids.
3. Supplies for a biological spill include: paper towels and a fresh 1:10 bleach solution.

# 5. Hazard Communication Act

The 69th Legislature of the State of Texas, in 1985, enacted the Texas Hazard Communication Act. The law became effective January 1, 1986 and has most recently been revised during Fall, 1993. The purpose of this law is to inform workers and the general public about chemical hazards in the workplace and in the community. The act requires public employers to provide their employees with information and training on hazardous chemicals to which they may be exposed to at work.

## A. REQUIREMENTS

### Training

1. New employees must receive training after they are hired and prior to working with or being exposed to chemicals. This training must cover the specific hazards in their work area.
2. Employees must be re-trained when new chemical hazards are introduced in their workplace or when new hazards are shown on updated Material Safety Data Sheets (MSDSs).
3. Employees must be re-trained when they are assigned to different workplaces that involve new chemical hazards.

### Labels

Every hazardous chemical container must have a label that identifies it and lists the appropriate hazard warnings. Do not deface or remove this label. When a chemical is transferred to a secondary container, the container must be labeled with the name of the chemical, physical hazard and health hazard, unless it is for the immediate use of the individual who made the transfer. Be sure to read the label before beginning work with any chemical.

### Material Safety Data Sheets (MSDS)

MSDS provide information on a specific chemical or mixture and must be readily available for all the hazardous chemicals in the lab. MSDS are available in specific departments and at EH&S as described in the next section. (See APPENDIX I for an example of an MSDS)

### Posters

Employee notification posters must be posted in the workplace and should be covered in training. These posters must be kept up-to-date. Employee notification posters are available through EH&S.

## B. MATERIAL SAFETY DATA SHEETS (MSDS)

MSDSs are the cornerstone of chemical hazard communication. They provide most of the information you need to know in order to work with chemicals safely. The EH&S Office maintains a master file (in hard copies) and can provide MSDS to University personnel who need them. Because MSDSs are so important they will be discussed in further detail. The following

information is normally contained in a MSDS:

### **Product Name and Identification**

1. Name of the chemical as it appears on the label.
2. Manufacturer's name and address.
3. Emergency telephone numbers: can be used to obtain further information about a chemical in the event of an emergency.
4. Chemical name or synonyms.
5. C.A.S. #: refers to the Chemical Abstract Service registry number which identifies the chemical.
6. Date of Preparation: the most current date that the MSDS was prepared.

### **Hazardous Ingredients/Identity Information**

1. Hazardous ingredients: are substances, which in sufficient concentration, can produce physical or acute or chronic health hazards to persons exposed to the product. Physical hazards include fire, explosions, corrosion, projectiles, etc. Health hazards include any health effect, even including irritation or development of allergies.
2. TLV: refers to the Threshold Limit Value. A TLV is the highest airborne concentration of a substance to which nearly all adults can be repeatedly exposed, day after day, without experiencing adverse effects. These are usually based on an eight hour time weighted average.
3. PEL: refers to the Permissible Exposure Limit. The PEL is an exposure limit established by OSHA.
4. STEL: refers to the Short Term Exposure Limit. The STEL is a 15 minute time weighted average exposure which should not be exceeded at any time during a workday. A STEL exposure should not occur more than four times per day and there should be at least 60 minutes between exposures.
5. LD<sub>50</sub> (lethal dose 50): lethal single dose (usually oral) in mg/kg (milligrams of chemical per kilogram of animal body weight) of a chemical that results in the death of 50% of a test animal population.
6. LC<sub>50</sub> (lethal concentration 50): concentration dose expressed in ppm for gases or micrograms of material per liter of air for dusts or mists that results in the death of 50% of a test animal population administered in one exposure.

**Note:** These terms are found in the Material Safety Data Sheets (MSDS).

### **Physical/Chemical Characteristics**

Boiling point, vapor pressure, vapor density, specific gravity, melting point, appearance and odor: all provide useful information about the chemical. Boiling point and vapor pressure provide a good

indication of how volatile a material is. Vapor density shows whether vapors will sink, rise, or disperse throughout the area. The further the values are from one (the value assigned to atmospheric air), the faster the vapors will sink or rise.

## **Fire and Explosion Hazard Data**

1. Flashpoint: refers to the lowest temperature at which a liquid gives off enough vapor to form an ignitable mixture with air.
2. Flammable or Explosive Limits: the range of concentrations over which a flammable vapor mixed with air will flash or explode if an ignition source is present.
3. Extinguishing Media: the fire fighting substance that is suitable for use on the substance which is burning.
4. Unusual Fire and Explosive Hazards: hazards that might occur as the result of overheating or burning of the specific material.

## **Reactivity Data**

1. Stability: indicates whether the material is stable or unstable under normal conditions of storage, handling, and use.
2. Incompatibility: lists any materials that would, upon contact with the chemical, cause the release of large amounts of energy, flammable vapor or gas, or toxic vapor or gas.
3. Hazardous Decomposition Products: any materials that may be produced in dangerous amounts if the specific material is exposed to burning, oxidation, heating, or allowed to react with other chemicals.
4. Hazardous Polymerization: a reaction with an extremely high or uncontrolled release of energy, caused by the material reacting with itself.

## **Health Hazard Data**

1. Routes of Entry: inhalation - breathing in of a gas, vapor, fume, mist, or dust. Skin absorption - a possible significant contribution to overall chemical exposure by way of absorption through the skin, mucous membranes, and eyes by direct or airborne contact. Ingestion - the taking up of a substance through the mouth. Injection - having a material penetrate the skin through a cut or by mechanical means.
2. Health Hazards (Acute and Chronic): acute - an adverse effect with symptoms developing rapidly. Chronic - an adverse effect that can be the same as an acute effect, except that the symptoms develop slowly over a long period of time or with recurrent exposures.
3. Carcinogen: a substance that is determined to be cancer producing or potentially cancer producing.

4. **Signs and Symptoms of Overexposure:** the most common symptoms or sensations a person could expect to experience from overexposure to a specific material. It is important to remember that only some symptoms will occur with exposures in most people.
5. **Emergency and First Aid Procedures:** instructions for treatment of a victim of acute inhalation, ingestion and skin or eye contact with a specific hazardous substance. The victim should be examined by a physician as soon as possible.

## **Precautions for Safe Handling and Use**

1. **Spill Clean-up:** includes methods to be used to control and clean up spills. Also includes precautions such as avoid breathing the vapors, avoid contact with liquids and solids, remove sources of ignition, and other important considerations. May also include special equipment used for the clean-up.
2. **Waste Disposal Methods:** acceptable and prohibited methods for disposal as well as dangers to the environment.

**Note:** These are methods recommended by the chemical manufacturer and are not necessarily in compliance with federal, state, or local regulations. For waste disposal procedures, please refer to the Chemical Waste section of this manual, or contact the EH&S Hazardous Material Section at 2185.

3. **Other Precautions:** any other precautionary measures not mentioned elsewhere in the MSDS.

## **Control Measures**

1. **Respiratory Protection:** whenever respiratory protection is needed, the type required and special conditions or limitations should be listed.
2. **Ventilation:** if required, the type will be listed as well as applicable conditions of use and limitations.
3. **Protective Gloves:** when gloves are necessary to handle the specific material, the construction, design, and material requirements should be listed.
4. **Eye Protection:** when special eye protection is required, the type will be listed along with any conditions of use and limitations.
5. **Other Protective Equipment or Clothing:** will list items not discussed elsewhere in the MSDS, such as aprons.

**Note:** A sample MSDS is included in the APPENDIX.

# 6. Chemical Hazards and Control

## A. CHEMICAL CATEGORIES AND USE AND STORAGE

Before using any chemical, carefully review the Material Safety Data Sheet (MSDS) and the label for information regarding the health hazards, personal protective equipment required for safe handling, and any other pertinent information associated with the use of that chemical. The information presented here is intended to aid you in determining the best way to store chemicals and use them safely.

### General Storage Guidelines

1. Store all chemicals by their hazard class and not in alphabetical order. Storing chemicals by alphabetical order will often result in incompatible chemicals being stored next to one another. Segregate chemicals into groups according to their hazards, e.g., flammables, toxins, reactives, and oxidizers. Within these groups, chemicals can be stored in alphabetical order to facilitate locating them. If a chemical exhibits more than one hazard, use the highest hazard(s) to segregate it.
2. Do not store chemicals near heat sources such as ovens or steam pipes. Also, do not store chemicals in direct sunlight.
3. Date chemicals when received and opened. This will assist you in using the oldest chemicals first, which will also decrease the amount of chemicals for disposal. If a particular chemical becomes unsafe upon storage, e.g., diethyl ether, then an expiration date should also be included. Keep in mind that expiration dates set by the manufacturer indicate the shelf life of the unopened container, and do not necessarily imply that the chemical is *safe* to use up to that date *after it has been opened*.
4. Do not use lab benches as permanent storage for chemicals. In these locations, the chemicals can be easily knocked over, incompatible chemicals can be stored next to one another, and the chemicals are unprotected from a fire situation. Each chemical should have a designated storage location and should be put there after use.
5. Inspect your chemicals routinely for any signs of deterioration and for the integrity of the label. To be in compliance with the Texas Hazard Communication Act, *all* chemicals must be clearly labeled. Another benefit of labeling is that unknown chemicals cannot be shipped as chemical waste until an expensive analysis has been performed to identify them. Everything should be done to prevent chemicals from becoming unknowns.
6. Do not store chemicals on the floor, especially chemicals in glass containers. It is too easy for containers to be knocked over, bumped into, or hit with a chair.
7. Do not use fumehoods as a permanent storage location for chemicals, with the exception of particularly odorous chemicals that may require ventilation. The more containers, boxes, equipment, and other items that are stored in a fumehood, the greater the likelihood of having chemical vapors being drawn back into the room. Some chemical fumehoods have ventilated storage cabinets underneath, and this is a good place to put chemicals that require ventilation.
8. Promptly contact the EH&S for the disposal of any old, outdated, or unused chemicals.

9. Chemicals that require refrigeration should be sealed with tight-fitting caps.
10. Do not store chemicals above eye level. If the container breaks, the contents can fall onto your face and upper body, which are generally unprotected areas.
11. Do not store excessive amounts of chemicals in a lab, as this wastes space and creates unnecessary hazards. Buying chemicals in bulk quantities has more disadvantages than advantages: limited work space, creation of a serious fire hazard, and disposal costs of unused chemicals are often higher than the initial purchase costs.

To simplify the discussion of safety considerations for particular chemicals that are found in laboratories, six categories have been developed. Many laboratory chemicals will fall within one of these six groups. Of course, many chemicals can fit into more than one category and in this case a decision would have to be made as to what is the most important characteristic about that chemical. For example, methanol does have toxic properties, but for the purpose of storage it should be stored with other flammables.

In general, chemicals within these categories will react similarly and will have similar properties. Being aware of the properties and characteristics of these general chemical categories will aid in the proper storage, handling, and use of chemicals.

**Flammables**  
**Oxidizers**  
**Corrosives**  
**Reactives**  
**Toxins**  
**Compressed Gases**

## **FLAMMABLES**

### General Characteristics

1. Flammable liquids are the most commonly found chemicals in a laboratory. Flammables can readily catch fire and burn. It is the vapor of a flammable liquid that burns, not the liquid itself.
2. The rate at which a flammable liquid produces flammable vapors depends upon its vapor pressure. The higher the vapor pressure, the more readily the liquid will vaporize. A chemical's vapor pressure also increases with increasing temperature. This makes flammable chemicals more hazardous when heated.
3. The flash point of a chemical is that minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air. Many commonly used flammables have flashpoints lower than room temperature, e.g., diethyl ether: Flashpoint of  $-45.0^{\circ}\text{C}$ , acetone: Flashpoint of  $-17.8^{\circ}\text{C}$ , and isopropyl alcohol: Flashpoint of  $11.7^{\circ}\text{C}$ .
4. The limits of flammability or explosivity define the range in which a flammable vapor or gas when mixed with air can ignite and burn. The low end of this range is called the Lower Explosive Limit



or LEL; the high end of this range is called the Upper Explosive Limit or UEL. If the vapor concentration in air is below the LEL or above the UEL, the mixture will not burn, but if the concentration is within these limits there is a very high risk of an explosion. The vapor in air concentration must be within the limits of flammability in order for it to ignite and burn.

Some flammable chemicals, such as benzene, have a very narrow flammability range, while others, such as acetaldehyde, have a very wide flammability range.

5. Most flammable vapors have a vapor density that is greater than that of air. The result is that these vapors will seek the lowest elevations. Flammable vapors can also travel great distances. When working with flammables, you must consider all the possible ignition sources, which may be located at a lower level and a distance from where the flammables are used.
6. *Examples of flammables:*
  - acetone
  - ethyl ether
  - toluene
  - methyl formate

## **Use and Storage**

1. Store flammable liquids that are not in use in safety cans, storage cabinets designed for flammables, or inside storage rooms.
2. Minimize the amount of flammable liquids stored in the lab.
3. Use flammables only in an area free of ignition sources. Remember, smoking is not permitted inside any University building.
4. When transferring flammables in metal containers, voltage potentials can result in static sparks capable of igniting flammable vapors. Flammable liquid dispensing and receiving containers must be bonded together before pouring. Large containers such as drums must also be grounded when used as a dispensing or receiving vessel. All grounding and bonding connections must be metal to metal. Safety catalogs carry the necessary bonding and grounding wires.
5. Never heat flammables by using an open flame. Use steam baths, water baths, oil baths, heating mantles, or hot air baths.
6. Never store flammable chemicals in a standard household refrigerator. There are several ignition sources located inside a standard refrigerator that can set off a fire or violent explosion. Flammables can only be stored cold in a lab safe or explosion-proof refrigerator. Another alternative is to use an ice bath to chill the chemicals. Remember, there is no safety benefit in storing a flammable chemical in a refrigerator if the flashpoint of that chemical is below the temperature of the refrigerator.

## **Health Hazards**

In general, the vapors of many flammables are irritating to mucous membranes of the respiratory system and eyes, and in high concentrations are narcotic. The following symptoms are typical for the respective routes of entry.

### **Acute Health Effects**

Inhalation - headache, fatigue, dizziness, drowsiness, narcosis (stupor and unresponsiveness)

Ingestion - slight gastro-intestinal irritation, dizziness, fatigue

Skin Contact - dry, cracked, and chapped skin

Eye Contact - stinging, watering eyes, and inflammation of the eyelids

### **Chronic Health Effects**

The chronic health effects will vary depending on the specific chemical, the duration of the exposure, and the extent of the exposure. However, damage to the lungs, liver, kidneys, heart and/or central nervous system may occur. Cancer and reproductive effects are also possible.

The following groups of flammables exhibit similarities in health effects.

Hydrocarbons - aliphatic hydrocarbons are narcotic but their systemic toxicity is relatively low. Aromatic hydrocarbons are all potent narcotic agents and overexposure to the vapors can lead to loss of muscular coordination, collapse, and unconsciousness. Benzene is toxic to bone marrow and can cause leukemia.

Alcohols - vapors only moderately narcotic.

Ethers - exhibit strong narcotic properties and for the most part are only moderately toxic.

Esters - vapors may result in irritation to the eyes, nose, and upper respiratory tract.

Ketones - systemic toxicity is generally not high.

### **First Aid**

Inhalation - remove person from the contaminated area if it is safe to do so. Get medical attention and do not leave person unattended.

Ingestion - remove the person from the source of contamination. Get medical attention. Do not induce vomiting.

Skin contact - remove person from source of contamination. Remove clothing, jewelry, and shoes from the affected areas. Flush the affected area with water for at least 15 minutes and get medical attention.

Eye contact - remove person from the source of contamination. Flush the eyes with water for at least 15 minutes. Get medical attention.

### **Personal Protective Equipment**

Always use a fumehood while working with flammable liquids. Nitrile and neoprene gloves are effective against most flammables. Wear a non-flammable lab coat to provide a barrier to your skin and goggles if splashing is likely to occur.

## **OXIDIZERS**

### **General Characteristics**

1. Oxidizers or 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.
2. Oxidizers are generally corrosive.
3. *Do not order or use anhydrous perchloric acid.* It is unstable at room temperature and can decompose spontaneously with a severe explosion. Anhydrous perchloric acid will explode in contact with wood or other organic materials.
4. Perchloric acid is an oxidizing agent of particular concern. The oxidizing power of perchloric acid increases with an increase in concentration and with an increase in temperature. Cold, 70% perchloric acid is a strong, non-oxidizing corrosive. A 72% perchloric acid solution at elevated temperatures is a strong oxidizing agent. A 85% perchloric acid solution is a strong oxidizer at room temperature.
5. *Examples of common oxidizers:*

peroxides	nitrates
nitrites	perchlorates
chlorates	chlorite
hypochlorite	dichromate
permanganate	persulfate

### **Use and Storage**

1. In general, store oxidizers away from flammables, organic compounds and combustible materials.
2. Strong oxidizing agents like chromic acid should be stored in glass or some other inert container, preferably unbreakable. Corks and rubber stoppers should not be used.
3. Reaction vessels containing appreciable amounts of oxidizing material should never be heated in oil baths, but rather on a heating mantle or sand bath.

#### **4. Use and Storage of Perchloric Acid**

- a. Perchloric acid deserves special mention within the category of oxidizing materials. A heated solution of perchloric acid is a very strong oxidizing agent.
- b.. *Do not attempt to heat perchloric acid if you do not have access to a properly functioning perchloric acid fumehood.* Perchloric acid can only be heated in a hood specially equipped with a washdown system to remove any perchloric acid residue. The hood should be washed down after each use and it is preferred to dedicate the hood to perchloric acid use only.
- c. Whenever possible, substitute a less hazardous chemical for perchloric acid.
- d.. Perchloric acid can be stored in a perchloric acid fumehood. Keep only the minimum amount necessary for your work. Another acceptable storage site for perchloric acid is on a metal shelf or in a metal cabinet away from organic or flammable materials. The bottle

of perchloric acid should also be stored in a glass secondary container to contain any leakage.

5. Do not allow perchloric acid to come in contact with any strong dehydrating agents such as sulfuric acid. The dehydration of perchloric acid is a severe fire and explosion hazard.

## **Health Hazards**

Oxidizers have been chosen as a group primarily due to their potential to add to the severity of a fire or to initiate a fire. But there are some generalizations that can be made regarding the health hazards of an oxidizing material. In general, oxidizers are corrosive and many are highly toxic.

## **Acute Health Effects**

Some oxidizers such as nitric and sulfuric acid vapors, chlorine, and hydrogen peroxide act as irritant gases. All irritant gases can cause inflammation in the surface layer of tissues when in direct contact. They can also cause irritation of the upper airways, conjunctiva, and throat. Some oxidizers, such as fluorine, can cause severe burns of the skin and mucus membranes. Chlorine trifluoride is extremely toxic and can cause severe burns to tissue. Nitrogen trioxide is very damaging to tissue especially the respiratory tract. The symptoms from an exposure to nitrogen trioxide may be delayed for hours, but fatal pulmonary edema may result.

## **Chronic Health Effects**

Nitrobenzene and chromium compounds can cause hematological and neurological changes. Compounds of chromium and manganese can cause liver and kidney disease. Chromium VI compounds have been associated with lung cancer.

## **First Aid**

In general, if a person has inhaled, ingested, or has come into direct contact with these materials the person must be removed from the source of contamination as quickly as possible, if it is safe to do so. Medical help must be summoned. In the case of an exposure directly to the skin or eyes it is imperative that the exposed person be taken to an emergency shower or eyewash immediately. Flush the affected area for a minimum of 15 minutes then get medical attention.

## **Personal Protective Equipment**

In many cases, the glove of choice will be neoprene, polyvinyl chloride (PVC), or nitrile. Be sure to consult a glove compatibility chart to ensure the glove material is appropriate for the particular chemical you are working with. Also, the glove manufacturer can be consulted for additional information.

Chemical Splash goggles must be worn if the potential for splashing exists or if exposure to vapor or gas is likely.

Always use these materials in a chemical fumehood as most do pose a hazard through the inhalation route. Cylinders of compressed gases should be kept in ventilated cabinets.

# **CORROSIVES**

## **General Characteristics**

1. Corrosives are most commonly acids and alkalis, but many other materials can also be severely

damaging to living tissue.

2. Corrosives can cause visible destruction or irreversible alterations 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.
3. Certain substances considered non-corrosive in their natural dry state, are corrosive when wet such as when in contact with moist skin or mucus membranes. An example of these materials are lithium chloride, halogen fluorides, and allyl iodide.
4. 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.
5. *Examples of corrosives:*

*sulfuric acid  
ammonium bifluoride  
chromic acid  
bromine  
stannic chloride  
ammonium hydroxide*

## **Use and Storage**

1. *Always store acids separately from bases. Also, store acids away from flammables, since many acids are also strong oxidizers.*
2. *Do not work with corrosives unless an emergency shower and continuous flow eyewash are available.*
3. *Always add acid to water, never add water to acid. This is to prevent splashing from the acid due to the generation of excessive heat as the two substances mix.*
4. Never store corrosives above eye level. Store on a low shelf or cabinet.
5. It is a good practice to store corrosives in a tray or bucket to contain any leakage.
6. When possible, purchase corrosives in containers that are coated with a protective plastic film that will minimize the danger to personnel if the container is dropped.
7. Store corrosives in a wooden cabinet or one that has a corrosion resistant lining. Corrosives stored in a metal cabinet will quickly damage it and if the supports that hold up the shelves become corroded the result could be disastrous.

## **Use and Storage of Hydrofluoric Acid**

1. Hydrofluoric acid is extremely hazardous and deserves special mention. Hydrofluoric acid can cause severe burns and inhalation of anhydrous hydrogen fluoride can be fatal. Hydrofluoric Acid readily penetrates the skin, damaging underlying tissue; fluoride ions can then cause destruction of soft tissues and decalcification of the bones.

2. Only persons fully trained in the hazards of hydrofluoric acid should use it.
3. Always use hydrofluoric acid in a properly functioning fume hood. Be sure to wear personal protective clothing!
4. If you suspect that you have come in direct contact with hydrofluoric acid: wash the area with water for at least 15 minutes, remove clothing, and then seek prompt medical attention. If hydrogen fluoride vapors have been inhaled, move the person immediately to an uncontaminated atmosphere (if it is safe to do so), keep the person warm, and seek prompt medical attention.
5. Never store hydrofluoric acid in a glass container because it is incompatible with glass.
6. Store hydrofluoric acid separately and keep only that amount necessary in the lab.

### **Health Hazards**

All corrosives possess the property of being severely damaging to living tissues and also attack other materials such as metal.

Skin contact with alkali metal hydroxides, e.g., sodium hydroxide and potassium hydroxide, is more dangerous than with strong acids. Contact with alkali metal hydroxides normally causes deeper tissue damage because there is less pain than with an acid exposure. The exposed person may not wash it off thoroughly enough or seek prompt medical attention. Acids on contact with skin generally form a protein layer which prevents further penetration and is painful, where alkali metal hydroxides do not.

All hydrogen halides are acids that are serious respiratory irritants and also cause severe burns.

Hydrofluoric acid is particularly dangerous. At low concentrations, hydrofluoric acid does not immediately show any signs or symptoms upon contact with skin. It may take several hours for the hydrofluoric acid to penetrate the skin before you would notice a burning sensation. However, by this time permanent damage, such as second and third degree burns with scarring, can result.

### **Acute Health Effects**

Inhalation - irritation of mucus membranes, difficulty in breathing, fits of coughing, 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, and with alkalis: a slippery, soapy feeling

Eye Contact - stinging, watering of eyes, swelling of eyelids, intense pain, ulceration of eyes, loss of eyes or eyesight

### **Chronic Health Effects**

Symptoms associated with a chronic exposure vary greatly depending on the chemical. For example, the chronic effect of hydrochloric acid is damage to the teeth; the chronic effects of hydrofluoric acid is increased bone density, fluorosis, and anemia; the chronic effects of sodium hydroxide are unknown.

### **First Aid**

Inhalation - remove person from source of contamination if it is safe to do so. Get medical attention. Keep person 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 water. Remove clothing, shoes, socks, and jewelry from affected areas as quickly as possible, cutting them off if necessary. Be careful not to get any chemical on your skin or inhale the vapors. Flush the affected area with water for a minimum of 15 minutes. Get medical attention.

Eye Contact - remove person from source of contamination and take immediately to an eyewash or source of water. Rinse the eyes for a minimum of 15 minutes. Have the person rotate his eyes up and down and from side to side while flushing with water. Get medical attention. Do not let person rub his eyes or keep them tightly shut.

### **Personal Protective Equipment**

Neoprene and nitrile gloves are effective against most acids and bases. Polyvinyl chloride (PVC) is also effective for most acids. Always wear the proper gloves when working with acids. A rubber coated apron and goggles should also be worn. If splashing is likely to occur, wear a faceshield over the goggles. Always use corrosives in a chemical fumehood.

## **REACTIVES**

### **General Characteristics**

#### **Polymerization Reactions**

Polymerization is a chemical reaction in which two or more molecules of a substance combine to form repeating structural units of the original molecule. This can result in an extremely high or uncontrolled release of energy. An example of a chemical which can undergo a polymerization reaction is polyvinylbenzene.

#### **Water Reactive Materials**

1. When water reactive materials come in contact with water, one or more of the following can occur: liberation of heat which may cause ignition of the chemical itself if it is flammable, or ignition of flammables that are stored nearby; release of a flammable, toxic, or strong oxidizing gas; release of metal oxide fumes; and formation of corrosive acids.
2. Water reactive chemicals can be particularly hazardous to fire fighting personnel responding to a fire in a lab, because water is the most commonly used fire extinguishing medium.
3. **Examples of water reactive materials:**
  - alkali metals (e.g., lithium)
  - silanes
  - sodium, potassium
  - alkylaluminums

magnesium  
zinc  
aluminum

## Pyrophorics

1. Pyrophoric materials can ignite spontaneously in the presence of air.
2. Examples of pyrophoric materials:

diethylzinc  
triethylaluminum  
many organometallic compounds

## Peroxide-Forming Materials

1. Peroxides are very unstable, and some chemicals that can form them are commonly used in laboratories. This makes peroxide-forming materials some of the most hazardous substances found in a lab. Peroxide-forming materials are chemicals that react with air, moisture, or impurities to form organic peroxides. Peroxide formation by most of these materials is greatly increased by evaporation or distillation. Organic peroxide compounds 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 heat to cause a severe explosion.
2. Examples of peroxide forming materials (the first group listed is the most hazardous):

isopropyl ether	divinylacetylene
sodium amide	potassium amide
dioxane	diethyl ether
tetrahydrofuran	vinyl ethers
butadiene	vinylpyridine
acrylonitrile	styrene

## Other Shock-Sensitive Materials

1. These materials are explosive and are sensitive to heat and shock.
2. Examples of other shock sensitive materials:

chemicals containing nitro groups  
fulminates  
hydrogen peroxide (30% +)  
ammonium perchlorate  
benzoyl peroxide (when dry)  
Compounds containing the following functional groups: acetylide, azide, diazo, halamine, nitroso, and ozonide.



**Note:** See APPENDIX-III for a more complete list of potentially explosive chemicals.

## **Use and Storage**

1. A good way to reduce the potential risks is to minimize the amount of material used in the experiment. Use only the amount of material necessary to achieve the desired results.
2. Always substitute a less hazardous chemical for a highly reactive chemical whenever possible. If it is necessary to use a highly reactive chemical, only order the amount that is necessary for the work.

## **Water Reactive Materials**

Store water-reactive chemicals in an isolated part of the lab. A cabinet away from any water sources, such as sinks, emergency showers, and chillers, is an appropriate location. Clearly label the cabinet "Water-Reactive Chemicals – No Water".

## **Pyrophorics**

Store pyrophorics in an isolated part of the lab and in a clearly marked cabinet. Be sure to routinely check the integrity of the container and have the material disposed of through EH&S if the container is corroded or otherwise damaged.

## **Peroxide-Forming Materials**

1. Do not open the chemical container if peroxide formation may have occurred. The act of opening the container could be sufficient to cause a severe explosion. Visually inspect liquid peroxide-forming materials for crystals or unusual viscosity before opening. Pay special attention to the area around the cap. Peroxides usually form upon evaporation, so they will most likely be formed on the threads under the cap.
2. Date all peroxide forming materials with the date received, opened, and the expected shelf life. Chemicals such as isopropyl ether, divinyl acetylene, sodium amide, and vinylidene chloride should be discarded after three months. Chemicals such as dioxane, diethyl ether, and tetrahydrofuran should be discarded after one year.
3. Store all peroxide forming materials away from heat, sunlight, and sources of ignition. All organic peroxides are highly flammable and sunlight accelerates the formation of peroxides.
4. Secure the lids and caps on these containers to discourage the evaporation and concentration of these chemicals.
5. Never store peroxide-forming materials in glass containers with screw cap lids or glass stoppers. Friction and grinding must be avoided. Also, never store these chemicals in a clear glass bottle where they would be exposed to light.
6. A test can be performed to check for the presence of peroxides in ethers. However, if you suspect that peroxides may be present, it is probably wise to call the EH&S for disposal. If you notice crystal formation in the container or around the cap, do not attempt to open or move the container. Call the EH&S for proper disposal.
7. Never distill ether unless it is known to be free of peroxides.

## **Other Shock Sensitive Materials**

Store these materials separately from other chemicals and in a clearly labeled cabinet.

1. Never allow picric acid to dry out; it is extremely explosive. Always store picric acid in a wetted state.

## **Health Hazards**

Reactive chemicals are grouped together as a category primarily because of the safety hazards associated with their use and storage and not because of similar acute or chronic health effects. For health hazard information on specific reactive materials consult the MSDS, the manufacturer, or EH&S.

However, there are some hazards common to the use of reactive materials. Injuries can occur due to heat or flames; hearing loss can result; respiratory injuries can occur due to inhalation of fumes, vapors, and reaction products; and a very serious hazard is flying debris which can inflict physical injuries.

## **First Aid**

If someone is seriously injured the most important step to take is to contact emergency responders as quickly as possible. This is best accomplished by directly calling the UTA Police Department, 3003. Explain the situation clearly and accurately.

If someone is severely bleeding apply a sterile dressing, clean cloth, or handkerchief to the wound. Place the palm of your hand directly over the wound and apply pressure. Continue to apply pressure until help arrives and keep the person calm.

If a person is on fire, have them drop immediately to the floor and roll. If a fire blanket is available put it over them. An emergency shower can also be used to douse flames if one is immediately available.

If a person is going into shock, have them lie down on their back if it is safe to do so and raise the feet about one foot above the floor.

## **Personal Protective Equipment**

Wear appropriate personal protective clothing while working with highly reactive materials. This might include: impact resistant chemical splash goggles, a faceshield, gloves, a lab coat (to minimize injuries from flying glass or an explosive flash), and a shield. Conduct work within a chemical fumehood as much as possible and pull down the sash as far as is practical. When the experiment does not require you to reach into the fumehood, keep the sash closed.

Barriers can offer protection of personnel against explosions and should be used. Many safety catalogs offer commercial shields which are commonly polycarbonate and are weighted at the bottom for stability. It may be necessary to secure the shields firmly to the work surface.

## **TOXINS**

### **General Characteristics**

1. Any chemical at the right dose could be toxic to humans. However, there are some chemicals that are known to be hazardous at very low concentrations, over a very short exposure time, or after

repeated exposures. These chemicals are the toxins, poisons, and carcinogens.

2. A toxin may be mutagenic and cause a heritable change in the gene structure or may also be teratogenic and cause a malformation of an embryo. Pregnant women and persons in their childbearing years should not work with or, at a minimum, use extreme caution while handling these materials.
3. The toxicity of a material is due to its ability to interfere with the metabolism of living tissue. An acute toxin can cause an adverse effect after a single or short duration exposure. A chronic toxin causes an adverse effect after repeated exposures, after a long duration single exposure, or after a long latency period. Carcinogens are examples of chronic toxins that have a long latency period before the effects of the exposure are observed.
4. **Examples of acute toxins:**
  - hydrogen cyanide
  - diisopropyl fluorophosphate
  - hydrogen sulfide
  - hydrofluoric acid
  - nitrogen dioxide
  - phosgene
5. **Examples of chronic toxins:**
  - all carcinogens
  - many metals and their compounds

## **Use and Storage**

1. All exposure to chemicals that are known to be highly toxic must be minimized by substituting a less hazardous chemical, decreasing the exposure time to the chemical, wearing protective clothing, practicing safe laboratory techniques, and using properly functioning laboratory safety equipment such as fumehoods or biological safety cabinets, as appropriate.
2. Do not eat, drink, smoke, or apply cosmetics in an area where toxic chemicals are used or stored, or without washing hands after using such chemicals.
3. Thoroughly wash your hands and arms before leaving the work area and at the end of the day.
4. Store containers of toxic materials in pans, trays, or other secondary containers to minimize hazards if the containers were to break or the contents spilled.
5. Use absorbent paper on the work surface to contain spills.
6. Restrict access where toxic materials are used and post signs if special toxicity hazards exist.
7. Vacuum pumps that are used with materials having high chronic toxicity should be protected by high-efficiency scrubbers or HEPA filters and vented into a chemical fumehood.
8. Store toxic chemicals separately in a clearly labeled cabinet. Do not allow personnel to work with toxins until they have been properly trained in their hazards, use, storage, and proper handling. If other hazards also apply to toxic chemicals, store as appropriate to those hazards.

## **Health Hazards**

The health hazards of toxic materials varies greatly. For information on specific materials contact EH&S, MSDSs, or the manufacturer.

## **First Aid**

Remove the person from the source of contamination if it is safe to do so. Get medical attention immediately. Try to determine exactly what the person has been exposed to and provide this information to the emergency responders. Provide a copy of the MSDS to the emergency responders if at all possible.

## **Personal Protective Equipment**

Protect your skin, eyes, and respiratory tract by using the appropriate engineering controls such as fumehoods and gloveboxes and by using personal protective clothing such as gloves and lab coats.

Before beginning work, you can contact EH&S to have the chemical fumehood tested. If a positive pressure glovebox is used, the box must be tested for leaks before each use and the exit gasses must be passed through a suitable trap or filter.

## **COMPRESSED GAS CYLINDERS**

### **General Characteristics**

1. Cylinders of compressed gases can pose a chemical hazard as well as a physical hazard.
2. If the valve were to break off a cylinder, the amount of force present could propel the cylinder through a brick wall. For example, a cylinder of compressed breathing air used by SCUBA divers has the explosive force of 1 1/2 pounds of TNT.

### **Use and Storage**

1. Use toxic, flammable, or reactive gases only in a fumehood or other ventilated enclosure.
2. Always use the appropriate regulator on a cylinder. If a regulator will not fit a cylinder's valve, replace the cylinder, not the regulator. Do not ever attempt to adapt or modify a regulator to fit a cylinder it was not designed for. Regulators are designed to fit only specific cylinder valves to avoid improper use.
3. Inspect regulators, pressure relief devices, valves, cylinder connections, and hoses frequently for damage.
4. Never use a cylinder that cannot be positively identified. Color coding is not a reliable way of identifying a cylinder because the colors can vary from supplier to supplier.
5. Do not use oil or grease on any cylinder component of an oxidizing gas because a fire or explosion can result.
6. Never transfer gases from one cylinder to another. The gas may be incompatible with the residual gas remaining in the cylinder or may be incompatible with the material that the cylinder is made of.
7. Never completely empty cylinders; rather, leave approximately 25 psi of pressure. This will

- prevent any residual gas in the cylinder from becoming contaminated.
8. Place all cylinders so that the main valve is always accessible.
  9. Close the main cylinder valve whenever the cylinder is not in use.
  10. Remove regulators from unused cylinders and always put the safety cap in place to protect the valve.
  11. **Always secure cylinders, whether empty or full**, to prevent them from falling over and damaging the valve (or falling on your foot). Secure cylinders by chaining or strapping them to a wall, lab bench, or other fixed support.
  12. Oxygen should be stored in an area that is at least 20 feet away from any flammable or combustible materials or separated from them by a noncombustible barrier at least 5 feet high and having a fire-resistance rating of at least 1/2 hour.
  13. To transport a cylinder, put on the safety cap and strap the cylinder to a handtruck in an upright position. Never roll a cylinder.
  14. Always clearly mark empty cylinders and store them separately.
  15. Be careful while handling compressed gas cylinders and never drop or strike a cylinder against anything.
  16. Use only wrenches or other tools supplied by the cylinder supplier to open a valve. Open cylinder valves slowly.

## **Gas Cylinder Policy**

Due to the tremendous cost involved with the disposal of non-returnable compressed gas cylinders and the potential safety risks associated with unknown cylinders, the University now has a Gas Cylinder Policy in effect.

1. The purchase of any gases in non-returnable cylinders is prohibited.
2. All users will be responsible for returning all cylinders to the manufacturer/distributor.
3. Cylinders of gases classified as corrosive or highly reactive shall be returned to the manufacturer/distributor within one year of the purchase date and all other gases within three years.

## **B. PERSONAL PROTECTIVE CLOTHING**

The most important thing to remember about protective clothing is that it only protects you if you wear it. Material Safety Data Sheets or other references should be consulted for information on the type of protective clothing that is required for the particular work you are performing.

### **Protective Eyewear**

1. Goggles provide the best all around protection against chemical splashes, vapors, dusts, and

mists.

2. Goggles that have indirect vents or are non-vented provide the most protection, but an anti-fog agent may need to be applied.
3. Standard safety glasses provide protection against impact.
4. If using a laser, wear safety glasses or goggles, which provide protection against the specific wavelength of that laser.
5. Remember, prescription glasses do not provide adequate protection in a laboratory setting. Prescription safety glasses can be purchased from most opticians. Also, the University has arranged with a vendor to supply prescription safety glasses to personnel at a reduced cost. Contact EH&S, 2185, for further information.
6. Contact lenses should not be worn in a laboratory because they can trap contaminants under them and reduce or eliminate the effectiveness of flushing with water from an eyewash. Contact lenses may also increase the amount of chemical trapped on the surface of the eye and decrease removal of the chemical by flushing with tears. If it is necessary to wear contact lenses in a lab, wear protective goggles at all times.

## **Protective Gloves**

1. Any glove can be permeated by chemicals. The rate at which this occurs depends on the composition of the glove, the chemicals present and their concentration, and the exposure time to the glove. This is why it is important to replace your gloves frequently throughout the day. Also, wash your hands regularly and remove gloves before answering the telephone or opening the door to prevent the spread of contamination.
2. If you are not certain which type of glove provides you with the protection you need, contact the manufacturer and ask for specifics on that glove.
3. Check gloves for cracks, tears, and holes before use.
4. Butyl, neoprene, and nitrile gloves are resistant to most chemicals, e.g., alcohols, aldehydes, ketones, most inorganic acids and most caustics.
5. Disposable latex and vinyl gloves protect against some chemicals, most aqueous solutions, and microorganisms as well as reduce the risk of product contamination.
6. Leather and some knit gloves will protect against cuts, abrasions, and scratches, but do not protect against chemicals.
7. Temperature-resistant gloves protect against cryogenic liquids, flames, and high temperatures.

## **Other Protective Clothing**

1. There are many types of lab coats available. The primary purpose of a lab coat is to protect against splashes and spills. A lab coat should be nonflammable and be easily removed.
2. Rubber coated aprons can be worn to protect against chemical splashes and may be worn over a lab coat for additional protection.

3. Face shields can protect against impact, dust, particulates, and chemical splashes for the face, eyes, and throat. However, always wear protective eyewear such as goggles underneath a face shield because a face shield only offers additional protection to the eyes. Chemical vapors and splashes can still travel under and around a face shield. If scratches or cracks are noticed in the face shield, replace the window.
4. Shoes which fully cover the feet should always be worn in a lab. If work is going to be performed that includes moving large and heavy objects such as 55 gallon drums then steel-toed shoes must be worn.

## **C. CHEMICAL SAFETY EQUIPMENT**

Chemical safety equipment includes chemical fumehoods and canopy hoods. This equipment is provided in laboratories to enable you to work safely with chemicals. In order to use this equipment properly you should have a general understanding of how it works.

### **Chemical Fume Hood Description**

1. There are basically five different types of chemical fume hoods: standard, bypass, auxiliary air, perchloric acid, and hoods used for radioisotopes.
2. All chemical fume hoods work in the following way:
  - a. air is drawn through the front opening of the fume hood, across the work surface, and through one or more baffles at the rear of the hood;
  - b. air flows up through the ductwork and into the blower, which should be located on the roof;
  - c. air flows through the exhaust stack and into the atmosphere, away from the building and any air intakes.

### **Standard Fume Hoods**

1. Standard fume hoods consist of a vertically sliding sash (which may have horizontally sliding panes of glass), rear baffle(s), a blower, and a ductwork that connects the hood to the blower.
2. The fan selected will draw a certain volume of air through the face of the hood at a certain rate, usually 100 feet per minute (fpm). The velocity through the hood opening will vary depending on the position of the sash. As the sash is lowered, the velocity through the hood opening will increase. The hood should not be operated with the sash raised above the height indicated on the EH&S inspection sticker.
3. The velocity can be so great that it can knock over graduated cylinders or pull paper up into the blower. This is a disadvantage of this type of hood.

### **Bypass Fume Hoods**

1. Consist of the same elements as a standard fume hood with the addition of a bypass. The bypass is

a grille or set of louvers located at the upper front side of the hood.

2. The operation of the bypass depends on the position of the sash. When the sash is wide open, the bypass is blocked - when the sash is lowered, air will flow through the bypass as well as through the front opening of the hood.
3. This design keeps the velocity through the face of the hood fairly constant and eliminates the problem of having very high velocities at the hood opening.

### **Auxiliary Air Fume Hoods**

1. An auxiliary air fume hood consists of the same elements as a bypass hood with the addition of an outside air supply. An additional blower and ductwork are required to supply outside air to the hood opening.
2. This fume hood design is energy efficient because a smaller volume of conditioned room air is exhausted through the hood.
3. Auxiliary air fume hoods also have disadvantages: cold or hot outside air may be blown onto the user of the hood, and these hoods are difficult to design so that they perform properly.

### **Perchloric Acid Fume Hoods**

1. A perchloric acid fume hood is a special adaptation of a standard, bypass, or auxiliary air fume hood for the use of perchloric acid.
2. The hood is constructed of stainless steel and other non-reactive materials. It is equipped with water sprays along the length of the exhaust duct, including near the blower and inside the top of the fume hood.
3. The water sprays are activated to wash down any perchloric acid residues that may have been deposited within the fume hood system. The fume hood should be washed down after each use.
4. Perchloric acid residues are potentially explosive!
5. Ideally, perchloric acid fume hoods should be used for perchloric acid only. If organics must be used in a perchloric acid hood, thoroughly wash down the fume hood first. Never use perchloric acid and organics in the hood at the same time. Perchloric acid in contact with organic materials can cause ignition.

### **Radioisotope Fume Hoods**

1. This type of hood is constructed and sealed to eliminate any cracks or crevices that may allow the accumulation of radioactive materials. It may be a standard, bypass, or auxiliary air fume hood.
2. The interior of the fume hood should be designed to be easy to clean and contain any spills that might occur within it.

### **Proper Use of Chemical Fume Hoods**

1. Equipment and other materials should be placed at least six inches behind the sash. This will



reduce the exposure of personnel to chemical vapors that may escape into the lab due to air turbulence.

2. When the hood is not in use, pull the sash all the way down. While personnel are working at the hood, pull down the sash as far as is practical. The sash is your protection against fires, explosions, chemical splashes, and projectiles.
3. Do not keep loose papers, paper towels, or Kim wipes in the hood. These materials can get drawn into the blower and adversely affect the performance of the hood.
4. Do not use a fume hood as a storage cabinet for chemicals. This is not what they are designed for. Excessive storage of chemicals and other items will disrupt the airflow in the hood. In particular, do not store chemicals against the baffle at the back of the hood. This is where the majority of the air is exhausted.
5. If large equipment must be kept in a fume hood, raise it 1.5 inches off the work surface to allow air to flow underneath. This dramatically reduces the turbulence within the hood and increases its efficiency.
6. Do not place objects directly in front of a fume hood (such as refrigerators or lab coats hanging on the manual controls) as this can disrupt the airflow and draw contaminants out of the hood.
7. Keep in mind that modifications made to a fume hood system, e.g., adding a snorkel, can render the entire system ineffective.
8. Minimize the amount of foot traffic immediately in front of a hood. People walking past hoods cause turbulence that can draw contaminants out of the hood and into the room.
9. EH&S inspects chemical fume hoods annually to ensure they are working properly. If you suspect that your fume hood is not working properly or for any other questions regarding fume hoods, call our Hazardous Materials Section at 2185.

## **Canopy Hoods**

1. Canopy hoods are generally suspended from the ceiling, usually overhanging an exhaust port of some equipment.
2. The capture velocity of a canopy hood quickly diminishes at a distance from the source of the contaminant. This makes canopy hoods very limited in their effectiveness at removing contaminants.
3. To assist a canopy hood in capturing and exhausting chemical vapors, the chemicals should be heated to help raise the vapors and the canopy hood should be placed as close to the equipment as possible. An example where a canopy hood is useful is at an exhaust port of an atomic absorption unit.

## **7. BIOLOGICAL HAZARDS AND CONTROL**

Personnel who work in biological laboratories may handle infectious agents in addition to other hazards such as chemicals and radioactive materials. Over the years, there have been many documented cases of lab personnel acquiring diseases due to their work with infectious agents. Only approximately 20% of these cases have been attributed to a specific incident, the rest are assumed to be related to work practices in the lab, primarily the creation of aerosols. Whenever work with infectious agents is performed, all appropriate steps must be taken to protect personnel and the environment.

### **A. RECOMMENDED LABORATORY PRACTICES**

There are basically four routes of exposure or four ways in which a person can come in contact with infectious agents. These routes are contact with the skin or mucus membranes, ingestion, inhalation, and inoculation. Each of these routes of exposure is discussed below.

#### **Contact with skin or mucus membranes**

Spilled material can come into direct contact on the skin as can droplets produced by pipetting, removal of screw caps, and vortex mixing of unsealed tubes.

1. The control of a contact exposure is accomplished through the wearing of appropriate protective clothing such as a faceshield, gloves, safety glasses, a mask, and laboratory coats. Other ways to control contact exposure include using absorbent paper on the work bench, performing all procedures carefully, and frequently wiping work surfaces with a disinfectant.
2. Keep all non-essential items away from the area where work is being performed to protect personal items from contamination. All contaminated wastes must be handled and stored properly to prevent contact exposure of lab personnel as well as housekeeping staff and waste handlers.

#### **Ingestion**

Ingestion may occur either directly or indirectly. Exposure may occur from mouth pipetting or splashing from a container into the mouth or by contaminating the hands and then touching the mouth or items, such as a coffee cup, food, or lip balm, that go into the mouth.

The control of an ingestion exposure is accomplished through the use of mechanical pipetting devices whenever pipetting and by practicing good personal hygiene, such as washing hands frequently throughout the day and not eating or drinking in the work area. Food items also cannot be stored in refrigerators that contain hazardous materials or in the lab where work with infectious agents is being performed.

#### **Inhalation**

It is generally known that aerosols are the primary means by which infectious diseases are spread and contracted. An aerosol can either be a liquid or a dry particle. An aerosol with a diameter of five microns or less can easily be inhaled and carried to the alveoli of the lungs. These aerosols can remain airborne for a long period of time and can spread wide distances, especially after entering the ventilation system. Particles with a diameter larger than five microns tend to settle rapidly and can

contaminate the skin or other surfaces. There are many commonly performed procedures in the lab that can create aerosols. Examples include centrifuging, heating inoculating loops, using a blender, blowing out the last drop in a pipette, and changing animal bedding.

The control of an inhalation exposure is accomplished by a combination of using the appropriate safety equipment such as biological safety cabinets and by performing procedures carefully to minimize the creation of aerosols. Refer to the following section on Laboratory Equipment for additional information.

## **Inoculation**

Inoculation in a lab usually occurs with a needle and syringe. Exercise extreme caution whenever using a needle. Restrict needle use; whenever an alternative to a needle is possible, it should be used. Inoculation can also occur through animal bites and other sharps such as Pasteur pipettes and razor blades.

The control of an inoculation hazard is accomplished by the safe use, handling, and storage of needles and other sharps. After using a needle, do not re-cap, bend, break, remove it from the syringe, or manipulate it in any way. Many people have been accidentally stuck with a needle during the process of re-capping it. The needle and other sharps should simply be placed into a sharps container to prevent any injuries. Call EH&S, Ext. 2185, for sharps containers.

## **B. LABORATORY EQUIPMENT**

### **Biological Safety Cabinets**

A biological safety cabinet (BSC) is used as a primary barrier against exposure to infectious biological agents. A BSC has High Efficiency Particulate Air (HEPA) filters. The airflow in a BSC is laminar, i.e., the air moves with uniform velocity in one direction along parallel flow lines. A BSC must be used in conjunction with safe laboratory techniques, because potentially dangerous aerosols can still escape.

Depending on the design, a BSC may be vented to the outside or the air may be exhausted into the room. BSCs are not chemical fume hoods. A percentage of the air is recirculated in most types of BSCs. Therefore, the levels of explosive, flammable, or toxic materials will be concentrated within the cabinet. HEPA filters only trap particulates, allowing any contaminant in non-particulate form to pass through the filter.

Types of BSCs

#### **Class I**

In Class I BSCs, the exhaust air is HEPA filtered so the user and the environment are protected, but the product inside the cabinet is not. With a Class I cabinet, the user's hands and arms while inside the cabinet are exposed to the infectious materials. The Class I BSC is designed for general microbiological research with low to moderate risk agents, and is useful for containment of mixers, blenders, and other equipment.

#### **Class II**

There are different types of Class II BSCs, but they all offer HEPA filtered supply and exhaust

air. This type of cabinet will protect the user, environment, and the product, and is suitable for work assigned to Biosafety Levels 1, 2, or 3. Class II cabinets are the type most commonly used.

### Class III

These cabinets are often referred to as Gloveboxes. The Class III cabinet is gas-tight and under negative pressure. All work in the cabinet is performed through rubber gloves attached to entry portals. The Class III cabinet offers the highest level of protection from infectious aerosols. Class III cabinets are most suitable for work with agents that require BL3 or BL4 containment.

### **Proper Use of BSCs**

1. Before and after use, wipe the surface of the BSC with a suitable disinfectant, e.g., 70% alcohol or a 1:10 bleach solution.
2. Place everything that you will need inside the cabinet before beginning work, including a waste container. You should not have to penetrate the air barrier of the cabinet once work has begun.
3. Do not place anything on the air intake grilles as this will block the air supply.
4. A sign can be posted on the door of the room stating that the cabinet is in use.
5. You should prevent unnecessary opening and closing of doors as this will disrupt the airflow of the cabinet.
6. Always wear a lab coat while using the cabinet, and conduct your work at least four inches inside the cabinet.
7. Place burners to the rear of the cabinet to reduce air turbulence.
8. Place a disinfectant soaked towel on the work surface to contain any splatters or small spills that might occur.
9. Do not work in the BSC while the ultraviolet light is on. Ultraviolet light can quickly injure the eye.
10. When finished with your work procedure, cover the waste container and decontaminate the surfaces of any equipment that is not enclosed.
11. Operate the cabinet for five minutes after performing any work in it in order to purge airborne contaminants.
12. Remove the equipment from the cabinet and decontaminate the work surface.
13. Thoroughly wash your hands and arms.

### **Certification of BSCs**

A BSC must be certified annually, and after it has been newly installed, moved, or has had a filter replaced.

## **Clean Benches**

Clean benches (a.k.a. laminar flow benches) are not considered laboratory safety equipment. However, they deserve mention because they may be confused with BSCs. A clean bench is designed to protect the product from contamination, but it does not protect the user. The direction of airflow in a clean bench is toward the user.

## **Pipetting Devices**

In the past, some lab personnel were taught to mouth pipette. This practice has been known to result in many laboratory acquired infections. With the availability of mechanical pipetting devices, mouth pipetting is now strictly prohibited. Mouth pipetting should never be used, even for innocuous materials because you may, at some time, mistakenly mouth pipette something that is hazardous. To minimize aerosol production, a pipette should be drained with the tip against the inner wall of the receiving vessel. Never forcibly expel any hazardous material from a pipette.

## **Centrifuges, Sonicators, Homegenizers, and Blenders**

All of these instruments can create aerosols, and this must be considered with each use. The necessary precautions taken will depend upon what is being used in these instruments. If hazardous materials such as carcinogens, highly toxic or infectious agents are going to be placed in any of these instruments, then precautions must be taken to prevent an exposure of lab personnel to aerosols or liquids.

### **Centrifuges**

Centrifuges that have sealed buckets, safety trunnion cups, or sealed heads are effective at preventing the escape of aerosols and liquids. The potential for exposing people to a hazardous material used in a centrifuge is great if the centrifuge tube breaks without the use of the safety features mentioned above.

Routinely inspect your centrifuge to ensure leakage is not occurring. An indicator such as fluorescein can be used to detect leaks. The fluorescein can be added to water and then centrifuged as would your other materials. An ultraviolet light can then be used to detect the fluorescein's presence on work surfaces, floors, and walls.

### **Sonicators, Homegenizers, and Blenders**

Depending on the nature of the material being used in these instruments and also in centrifuges, it may be necessary for them to be used or opened only in a biological safety cabinet. When working with infectious agents, blenders should have leakproof bearings and a tight-fitting, gasketed lid. Inspect the lid and gaskets routinely to ensure they are in good condition. Household blenders do not prevent the spread of aerosols. Also, hearing protection may be required while using a sonicator.

## **C. PERSONAL PROTECTIVE CLOTHING**

The type of personal protective clothing required in microbiological labs will depend upon the assigned Biosafety Level (BL) for that lab (see a following section regarding assignment of Biosafety Levels).

The protective clothing suitable for a typical undergraduate microbiology lab is a lab coat to prevent street clothes from getting soiled and latex gloves. Long hair must be restrained if Bunsen burners are in use.

For a typical graduate level teaching or research microbiology lab (which are often a BL2), lab coats or similar protective clothing should be worn while in the lab, and gloves must be worn while handling any infectious materials. Additionally, if the work involves human blood, a faceshield, safety glasses or goggles, and a mask may be required if there is a potential for splash.

A research lab that is assigned a Biosafety Level 3 has additional requirements for personal protective clothing: Laboratory clothing that protects street clothing must be worn, e.g., a solid-front or wrap-around gown. Typical lab coats which button down the front are not acceptable because they do not fully protect you. Gloves must be worn in the lab, and respirators must be worn in rooms containing infected animals.

Whenever personal protective clothing knowingly becomes contaminated, it should be removed and replaced. Leave protective clothing in the lab and do not wear it to other non-lab areas. Disposable gloves are meant to be used only once and should then be discarded. In between glove changes, thoroughly wash your hands and arms.

## **D. WASTE DISPOSAL**

There are many types of waste generated in a microbiological lab and all need to be handled, treated, stored, and disposed of properly. Refer to the Chemical Waste and Special Wastes sections of this manual.

## **E. BLOODBORNE PATHOGENS**

In December of 1991, the Federal Government published the final rule governing occupational exposure to bloodborne pathogens which became effective March 6, 1992. The State of Texas is currently proposing a bloodborne pathogen standard for all public employers. The objective of these standards is to provide guidelines to eliminate or minimize employee exposure to human bloodborne pathogens. A human bloodborne pathogen is a pathogenic microorganism present in human blood that can cause disease in humans. The standard includes the Centers for Disease Control (CDC) guidelines referred to as Universal Precautions.

If during the course of your work you have the potential for coming in contact with human blood or other potentially infectious materials, you should receive training on bloodborne pathogens. Contact EH&S Hazardous Materials Section at 2185 for information regarding Bloodborne Pathogens Training.

The CDC Universal Precautions are used as an approach to infection control. The concept behind Universal Precautions is to treat all human blood and certain human body fluids as if known to be infected with HIV, Hepatitis B, and other bloodborne pathogens. The Universal Precautions are summarized below and should be practiced whenever coming in contact with human blood.

1. Use appropriate barrier precautions to prevent skin and mucus membrane exposure when contact with blood is anticipated. Always wear gloves. Wear masks and protective eyewear or faceshields to prevent exposure to the eyes, mouth, and nose during procedures that are likely to result in droplets of blood. Wear gowns or aprons during procedures that are likely to result in splashes of blood. Remove all protective clothing before leaving the laboratory.

2. Wash hands and other skin surfaces immediately if contaminated with blood and after the removal of gloves.
3. Limit the use of needles to situations in which there is no alternative, and take precautions to prevent injuries by needles and other sharps. To prevent needle-stick injuries, needles should not be recapped, bent, removed from the syringe, or otherwise manipulated by hand. Place needles and other sharps into puncture-resistant containers.
4. Keep all specimens of blood in well-constructed containers with a secure lid to prevent leakage during transport.
5. Use biological safety cabinets whenever procedures are conducted that have a high potential for generating droplets.
6. Never mouth pipette.
7. Decontaminate laboratory work surfaces after a spill of blood and when work activities are completed.

## **F. LABORATORY ANIMALS**

Some animals can also carry pathogens that can be transmitted to humans through contact with their body fluids, similar to human bloodborne pathogens. This contact can occur through biting, spitting, or contamination of broken skin or mucus membranes with bodily secretions from the animal.

The EH&S Office has adopted the National Research Council's "Guide for the Care and Use of Laboratory Animals" as a primary reference on animal care and use. The goal of the Guide is to promote the humane care of animals used in research, teaching, and testing. Each institution should establish and provide resources for an animal care and use program that is managed in accord with this Guide and in compliance with applicable federal, state, and local laws and regulations such as the Federal Animal Welfare Regulations and Public Health Service Policy on Humane Care and Use of Laboratory Animals. Departments conducting animal research must have an effective occupational health and safety program which ensures that the risks associated with the experimental use of animals are reduced to acceptable levels. Potential hazards such as animal bites, chemical cleaning agents, allergens, and zoonoses that are inherent in or intrinsic to animal use should be identified and evaluated.

Wear gloves, masks, and laboratory coats whenever entering an area where these animals are housed. Guidelines are available for safely working with laboratory animals and can be obtained by referring to the "Guide for the Care and Use of Laboratory Animals" or contacting the EH&S Hazardous Materials Section at 2185.

## **G. BIOSAFETY LEVELS**

The Centers for Disease Control (CDC) and the National Institutes of Health (NIH) have developed standard procedures providing protection against biological hazards. The publication *Biosafety in Microbiological and Biomedical Laboratories* provides specific descriptions of combinations of

microbiological practices, laboratory facilities, and safety equipment, and recommends their use in four biosafety levels of operation with infectious agents. These biosafety levels are described below.

The biosafety levels described in the NIH Guidelines for Research Involving DNA Molecules are based on and consistent with the biosafety levels presented here. A biosafety level (BL) is based on the potential hazard of the agent and the functions of the lab. BL1 is for work with agents that pose the least hazard and BL4 is for work with agents that pose the greatest hazard. Only BL1 through 3 are included here because there are not any BL4 labs at the University. All work with microbiological agents at the University should follow the CDC/NIH guidelines. If you are uncertain which biosafety level your work should be performed at, call the EH&S Hazardous Materials Section at 2185 for assistance.

## **Biosafety Level 1**

BL1 is suitable for work involving well-characterized agents not known to cause disease in healthy adult humans, and of minimal potential hazard to laboratory personnel and the environment. The laboratory is not necessarily separated from the general traffic patterns in the building. Work is generally conducted on open bench tops using standard microbiological practices. Special containment equipment or facility design is not required nor generally used. Laboratory personnel have specific training in the procedures conducted in the laboratory and are supervised by a scientist with general training in microbiology or a related science. The following standard and special practices, safety equipment, and facilities apply to agents assigned to BL1:

### **Standard Microbiological Practices (BL1)**

1. Access to the laboratory is limited or restricted at the discretion of the laboratory director when experiments or work with cultures and specimens is in progress.
2. Persons wash their hands after they handle viable materials and animals, after removing gloves, and before leaving the laboratory.
3. Eating, drinking, smoking, handling contact lenses, and applying cosmetics are not permitted in the work areas where there is reasonable likelihood of exposure to potentially infectious materials. Persons who wear contact lenses in laboratories should also wear goggles or a faceshield. Food is stored outside the work area in cabinets or refrigerators labeled and used for this purpose only.
4. Mouth pipetting is prohibited; mechanical pipetting devices are used.
5. All procedures are performed carefully to minimize the creation of splashes or aerosols.
6. Work surfaces are decontaminated at least once a day and after any spill of viable material.
7. Take special care when using "sharps," i.e., syringes, needles, Pasteur pipettes, capillary tubes, scalpels, and other sharp instruments.
8. All cultures, stocks, and other regulated wastes are decontaminated before disposal by an approved decontamination method, such as autoclaving. Materials to be decontaminated outside of the immediate laboratory are to be placed in a durable, leakproof container and closed for transport from the laboratory. Materials to be decontaminated off-site from the laboratory are packaged in accordance with applicable local, state, and federal regulations,



before removal from the facility. If you need assistance in acquiring the appropriate container, or have questions concerning disposal, contact EH&S, 2185.

9. An insect and rodent control program is in effect.

### **Special Practices (BL1)**

None.

### **Safety Equipment (Primary Barriers) (BL1)**

1. Special containment devices or equipment such as a biological safety cabinet are generally not required for manipulations of agents assigned to BL1.
2. It is recommended that laboratory coats, gowns, or uniforms be worn to prevent contamination or soiling of street clothes.
3. Gloves should be worn if the skin on the hands is broken or if a rash exists.
4. Protective eyewear should be worn for anticipated splashes of microorganisms or other hazardous materials to the face.

### **Laboratory Facilities (Secondary Barriers) (BL1)**

1. Each laboratory contains a sink for handwashing.
2. The laboratory is designed so that it can be easily cleaned. Rugs in laboratories are not appropriate and should not be used because proper decontamination following a spill is extremely difficult to achieve.
3. Bench tops are impervious to water and resistant to acids, alkalis, organic solvents, and moderate heat.
4. Laboratory furniture is sturdy. Spaces between benches, cabinets, and equipment are accessible for cleaning.
5. If the laboratory has windows that open, they are fitted with fly-proof screens.

### **Examples of BL1 Agents**

Bacillus subtilis  
Naegleria gruberi  
Infectious Canine Hepatitis Virus

### **Biosafety Level 2**

BL2 is similar to Level 1 and is suitable for work involving agents of moderate potential hazard to personnel and the environment. It differs in that (1) laboratory personnel have specific training in handling pathogenic agents and are directed by scientists, (2) access to the laboratory is limited when work is being conducted, (3) extreme precautions are taken with contaminated sharp items, and (4) certain procedures in which infectious aerosols or splashes may be created are conducted in biological safety cabinets or other physical containment equipment. In addition to all the requirements

for BL1, work at BL2 requires:

### **Special Practices (BL2)**

1. Access to the laboratory is limited or restricted by the laboratory director when work with infectious agents is in progress. In general, persons who are at increased risk of acquiring infection or for whom infection may be unusually hazardous are not allowed in the laboratory or animal rooms. For example, persons who are immunocompromised or immunosuppressed may be at risk of acquiring infections. The laboratory director has the final responsibility for assessing each circumstance and determining who may enter or work in the laboratory.
2. The laboratory director establishes policies and procedures whereby only persons who have been advised of the potential hazard and meet specific entry requirements (e.g., immunization) enter the laboratory or animal rooms.
3. When the infectious agent(s) in use in the laboratory require special provisions for entry (e.g., immunization), a hazard warning sign incorporating the universal biohazard symbol is posted on the access door to the laboratory work area. The hazard warning sign identifies the infectious agent, lists the name and telephone number of the laboratory director or other responsible person(s), and indicates the special requirement(s) for entering the laboratory.
4. Laboratory personnel receive appropriate immunizations or tests for the agents handled or potentially present in the laboratory (e.g., hepatitis B vaccine or TB skin testing).
5. When appropriate, considering the agent(s) handled, baseline serum samples for laboratory and other at-risk personnel are collected and stored. Additional serum specimens may be collected periodically, depending on the agents handled or the function of the facility.
6. A site-specific biosafety manual is prepared or adopted in addition to this University EH&S manual. Personnel are advised of special hazards and are required to read and follow instructions on practices and procedures.
7. Laboratory personnel receive appropriate training on the potential hazards associated with the work involved, the necessary precautions to prevent exposures, and the exposure evaluation procedures. Personnel receive annual updates, or additional training as necessary for procedural or policy changes.
8. A high degree of precaution must always be taken with any contaminated sharp item, including needles and syringes, slides, pipettes, capillary tubes, and scalpels. Needles and syringes or other sharp instruments should be restricted in the laboratory for use only when there is no alternative, such as parenteral injection, phlebotomy, or aspiration of fluids from laboratory animals and diaphragm bottles. Plasticware should be substituted for glassware whenever possible.
  - a. Only needle-locking syringes or disposable syringe-needle units (i.e., needle is integral to the syringe) are used for the injection or aspiration of infectious materials. Used disposable needles must not be bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal; rather, they must be carefully placed in conveniently located puncture-resistant containers used for sharps disposal. These sharps containers will be supplied by EH&S and will be removed by EH&S for disposal. Non-disposable sharps must be placed in a hard-walled container for transport to a processing area for de-contamination, preferably by autoclaving.

- b. Syringes that re-sheath the needle, needle-less systems, and other safe devices should be used when appropriate.
  - c. Broken glassware must not be handled directly by hand, but must be removed by mechanical means such as a brush and dustpan, tongs, or forceps.
9. Cultures, tissues, or specimens of body fluids are placed in a container that prevents leakage during collection, handling, processing, storage, transport, or shipping.
  10. Laboratory equipment and work surfaces should be decontaminated with an appropriate disinfectant on a routine basis, after work with infectious materials is finished, and especially after overt spills, splashes, or other contamination by infectious materials. Contaminated equipment must be decontaminated according to any local, state, or federal regulations before it is sent for repair or maintenance or packaged for transport in accordance with applicable local, state, or federal regulations, before removal from the facility.
  11. Spills and accidents which result in overt exposures to infectious materials are immediately reported to the laboratory director and EH&S Hazardous Materials Section, Ext. 2185. Medical evaluation, surveillance, and treatment are provided as appropriate and written records are maintained.
  12. Animals not involved in work being performed are not permitted in the laboratory.

### **Safety Equipment (Primary Barriers) (BL2)**

1. Properly maintained biological safety cabinets, preferably Class II, or other appropriate personal protective equipment or physical containment devices are used whenever:
  - a. Procedures with a potential for creating infectious aerosols or splashes are conducted. These include centrifuging, grinding, blending, vigorous shaking or mixing, sonic disruption, opening containers of infectious materials whose internal pressures may be different from ambient pressures, inoculating animals intranasally, and harvesting infected tissues from animals or eggs.
  - b. High concentrations or large volumes of infectious agents are used. Such materials may be centrifuged in the open laboratory if sealed rotor heads or centrifuge safety cups are used, and if these rotors or safety cups are opened only in a biological safety cabinet.
2. Face protection (goggles, mask, faceshield or other splatter guards) is used for anticipated splashes or sprays of infectious or other hazardous materials to the face, when the micro-organisms must be manipulated outside the BSC.
3. Protective laboratory coats, gowns, smocks, or uniforms designated for lab use are worn while in the laboratory. This protective clothing is removed and left in the laboratory before leaving for non-laboratory areas (e.g., cafeteria, library, administrative offices). All protective clothing is either disposed of in the laboratory or laundered by the institution; it should never be taken home by personnel.
4. Gloves are worn when handling infected animals and when hands may contact infectious materials, contaminated surfaces, or equipment. Wearing two pairs of gloves may be appropriate; if a spill or splatter occurs, the hand will be protected after the contaminated glove is removed. Gloves are disposed of when contaminated, removed when work with infectious materials is completed, and are not worn outside the laboratory. Disposable gloves are not washed or reused.

## Laboratory Facilities (Secondary Barriers) (BL2)

1. A method for decontamination of infectious or regulated laboratory wastes is available (e.g., autoclave, chemical disinfection, incinerator, or other approved decontamination system).
2. An eyewash facility is readily available.

### Examples of BL2 Agents

Bordetella pertussus

Cryptococcus neoformans

Clostridium tetani

Mycobacterium leprae

Shigella spp.

Hepatitis A & E virus

## Biosafety Level 3

BL3 is applicable to clinical, diagnostic, teaching, research, or production facilities in which work is done with indigenous or exotic agents that may cause serious or potentially lethal disease as a result of exposure by the inhalation route. Laboratory personnel have specific training in handling pathogenic and potentially lethal agents and are supervised by scientists who are experienced in working with these agents.

All procedures involving the manipulation of infectious material are conducted within biological safety cabinets or other physical containment devices or by personnel wearing appropriate personal protective clothing and equipment. The laboratory has special engineering and design features.

It is recognized that many existing facilities may not have all the facility safeguards recommended for BL3 (e.g., access zone, sealed penetrations, and directional airflow). In these circumstances, acceptable safety may be achieved for routine or repetitive operations (e.g., diagnostic procedures involving the propagation of an agent for identification, typing, and susceptibility testing) in BL2 facilities. However, the recommended Standard Microbiological Practices, Special Practices, and Safety Equipment for BL3 must be rigorously followed. The decision to implement this modification of BL3 recommendations should be made only by the laboratory director. In addition to all the requirements for BL2, work at BL3 requires:

### Special Practices (BL3)

1. Laboratory doors are kept closed when experiments are in progress.
2. The laboratory director controls access to the laboratory and restricts access to persons whose presence is required for program or support purposes.
3. The laboratory director is responsible for ensuring that before working with organisms at BL3,

all personnel demonstrate proficiency in standard microbiological practices and techniques, and in the practices and operations specific to the laboratory facility. This might include prior experience in handling human pathogens or cell cultures, or a specific training program provided by the laboratory director or other scientist proficient in safe microbiological practices and techniques.

4. All manipulations involving infectious materials are conducted in biological safety cabinets or other physical containment devices within the containment module. No work in open vessels is conducted on the open bench.
5. All potentially contaminated waste materials (e.g., gloves, lab coats, etc.) from laboratories or animal rooms are decontaminated before disposal or reuse.
6. Spills of infectious materials are decontaminated, contained and cleaned up by appropriate professional staff, or others properly trained and equipped to work with concentrated infectious material.

### **Safety Equipment (Primary Barriers) (BL3)**

1. Properly maintained biological safety cabinets are used (Class II or III) for all manipulation of infectious materials.
2. Outside of a BSC, appropriate combinations of personal protective equipment are used (e.g., special protective clothing, masks, gloves, face protection, or respirators), in combination with physical containment devices (e.g., centrifuge safety cups, sealed centrifuge rotors, or containment caging for animals).
3. This equipment must be used for manipulations of cultures and of those clinical or environmental materials that may be a source of infectious aerosols; the aerosol challenge of experimental animals; harvesting of tissues or fluids from infected animals and embryonated eggs, and necropsy of infected animals.
4. Respiratory protection is worn when aerosols cannot be safely contained (i.e., outside of a biological safety cabinet), and in rooms containing infected animals.
5. Protective laboratory clothing such as solid-front or wrap-around gowns, scrub suits, or coveralls must be worn in, and not worn outside, the laboratory. Reusable laboratory clothing is to be decontaminated before being laundered.

### **Laboratory Facilities (Secondary Barriers) (BL3)**

1. The laboratory is separated from areas that are open to unrestricted traffic flow within the building. Passage through two sets of self-closing doors is the basic requirement for entry into the laboratory from access corridors or other contiguous areas. A clothes change room (shower optional) may be included in the passage way.
2. Each laboratory contains a sink for handwashing. The sink is foot, elbow, or automatically operated and is located near the laboratory exit door.
3. The interior surfaces of walls, floors, and ceilings are water-resistant so that they can be easily cleaned. Penetrations in these surfaces are sealed or capable of being sealed to facilitate decontamination.

4. Windows in the laboratory are closed and sealed.
5. A method for decontaminating all laboratory wastes is available, preferably within the laboratory (i.e., autoclave, chemical disinfection, incineration, or other approved decontamination method).
6. A ducted exhaust air ventilation system is provided. This system creates directional airflow that draws air from "clean" areas into the laboratory toward "contaminated" areas. The exhaust air is not recirculated to any other area of the building, and is discharged to the outside with filtration and other treatment optional. The outside exhaust must be dispersed away from occupied areas and air intakes. Laboratory personnel must verify that the direction of airflow (into the laboratory) is proper.
7. The High Efficiency Particulate Air (HEPA) filtered exhaust air from Class II or Class III biological safety cabinets is discharged directly to the outside or through the building exhaust system. If the HEPA filtered exhaust air from Class II or Class III biological safety cabinets is to be discharged to the outside through the building exhaust air system, it is connected to this system in a manner (e.g., thimble unit connection) that avoids any interference with the air balance of the cabinets or building exhaust system. Exhaust air from Class II biological safety cabinets may be recirculated within the laboratory if the cabinet is tested and certified at least every twelve months.
8. Continuous flow centrifuges or other equipment that may produce aerosols are contained in devices that exhaust air through HEPA filters before discharge into the laboratory.
9. Vacuum lines are protected with liquid disinfectant traps and HEPA filters, or their equivalent, which are routinely maintained and replaced as needed.

### **Examples of BL3 Agents**

Vesicular Stomatitis Virus	
Yellow Fever Virus	
Francisella tularensis:	during manipulations of cultures and for experimental animal studies
Coxiella burnetti:	for activities involving inoculation, incubation, and harvesting of embryonated eggs or cell cultures, necropsy of infected animals, and manipulation of infected tissues

## **H. EMERGENCY PROCEDURES**

Refer to the Emergency Procedures and Equipment section of this manual for important information on emergency procedures. In this section some specific instructions will be given for the clean up of a biological spill.

Some biological materials when spilled or released can lead to significant infection exposures of personnel. This is particularly hazardous when the agent spilled or released is classified as a BL2

agent or higher. The following emergency procedures that should be followed are determined by the Biosafety Level of the agent involved.

### **Spills or Releases Involving BL1 Agents**

1. Wear a lab coat and disposable gloves.
2. Soak a paper towel(s) in an appropriate disinfectant such as a fresh 1:10 bleach solution and place over the spill area.
3. Place the paper towels and gloves into a bag for disposal.

### **Spills or Releases Involving BL2 Agents**

1. If an accident occurs that may generate aerosols or droplets of an infectious agent, leave the area, close the door, decontaminate clothing and shower. Allow 30 minutes for the droplets to settle and the aerosol concentration to decrease.
2. Wear appropriate personal protective clothing such as gloves, lab coat, and approved respiratory equipment.
3. Cover the spill area with paper towels, pour a 1:10 bleach solution around the edges of the spill and then into the spill. Allow 20 minutes contact time.
4. Use paper towels to clean the area, working from the outer edges into the center. Clean the spill area with fresh towels soaked in a disinfectant. Place all clean-up materials and gloves into a bag for decontamination, preferably by autoclaving. Wash thoroughly.
5. A small spill of material that did not result in a significant generation of aerosols or contamination of a person, can be cleaned up following steps two through four above.

### **Spills or Releases Involving BL3 Agents**

1. If the spill occurs in a biological safety cabinet, keep the cabinet running, and clean the spill following steps two through four from Spills or Releases Involving BL2 Agents, except that personal protective clothing appropriate for a BL3 lab will be worn. If the spill in the cabinet is quite substantial, it may be necessary to decontaminate the cabinet's fan, filters, and airflow plenums. This must be done by an outside company. Call the EH&S for assistance.
2. If a minor spill occurs outside of a biological safety cabinet, follow steps two through four from Spills or Releases Involving BL2 Agents, except that personal protective clothing appropriate for a BL3 lab will be worn.
3. If anything other than a minor spill occurs outside of a biological safety cabinet, leave the area immediately and notify appropriate personnel including EH&S. A specially designed

decontamination procedure may be necessary.

**Note:** Whenever bleach is used to clean up spills of an infectious agent, a

fresh solution should be prepared.

After about one week, a bleach and water solution will lose its effectiveness for



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## 8. RADIATION HAZARDS AND CONTROL

Radiation Hazards and Control are covered by the EH&S Radiation Safety Manual. This manual has been approved by The Texas Department of Health. The topics included in the manual are:

- Radiation Safety Program Management
- Radiation Facilities and Equipment
- Operational Procedures
- Radioisotope Accountability
- Instrumentation
- Tests and Records
- Disposal of Radioactive Waste
- Emergency Procedures
- Forms

Required training and the manual are available by calling the Radiation Section of the Environmental Health and Safety Office at 2185.

**Note** Radioactive waste that is also regulated chemical waste must also be managed in accordance with the procedures described in a following chapter entitled "Chemical Waste".

## 9. CONTROLLED SUBSTANCES, PRECURSOR CHEMICALS AND CHEMICAL LABORATORY APPARATUS

A May 29, 1997, memorandum from the Provost to the Dean of Science and applicable department chairs stated:

"In October, 1995, the Texas Department of Public Safety and the Texas Higher Education Coordinating Board signed an agreement (a Memorandum of Understanding, MOU) that, in accord with Health and Safety Code, Section 481.0621 (b), establishes procedures for maintaining controlled substances, controlled substance 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 addition to possible precursors for the manufacture of illicit drugs."

The procedures required for implementation of this MOU at UT-Arlington are described below. The objective of these implementation procedures is to define an institutional policy for the use of controlled items (chemical precursors and certain laboratory apparatus) on the campus of the University of Texas at Arlington. These procedures shall become effective May 1, 1997. Full compliance with this Memorandum is required.

The following is a list of the controlled items whose purchase, use, and disposal must be monitored:

### A. List of Precursor Items

#### Precursor Chemicals

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

#### Laboratory Apparatus

- A. Condensers
- B. Distilling apparatus
- C. Vacuum dryers
- D. Three-necked flasks
- E. Distilling flasks
- F. Tableting machines
- G. Encapsulating machines
- H. Filter funnels, Büchner funnels, and separatory funnels
- I. Erlenmeyer flasks, two-necked flasks, single neck flasks, round bottom flasks, thermometer flasks, and filtering flasks
- J. Soxhlet extractors
- K. Transformers
- L. Flask heaters
- M. Heating mantles
- N. Adapter tubes

The MOU, which was signed by the Director of the Texas Department of Public Safety (DPS) and the Commissioner of the Texas Higher Education Coordinating Board, commits the University to establishing procedures that specify: (1) personal responsibility for secure use of controlled items; (2) record-keeping

requirements for purchases; (3) procedures for disposal of unused controlled items; (4) security procedures governing use of the controlled items; and (5) a liaison between the University and DPS. Full text of the MOU is available at the Environmental Health & Safety Office (272-2185).

## **B. Responsibility**

Any person (herein called the Responsible Party, **RP**) who wishes to purchase or accept controlled items must bear full responsibility for establishing security measures regarding their purchase, acceptance, use, and ultimate disposal. If the control items are to be used in a research program supervised by an individual faculty member, the **Principal Investigator (PI)** becomes, therefore, the **RP**, and must assume full responsibility. If the controlled items are to be used in a teaching laboratory or in a demonstration for an organized class, the **Chair** of the department through which the academic course is offered becomes the **RP**.

## **C. Purchase Orders**

The Contracting, Purchasing & General Services Office has put in place a purchasing and record keeping program to assist in tracking controlled items. These records can be obtained upon request by the **RP** (as defined above) or by any state or federal agency so authorized by law. All orders for a controlled item must be submitted by the **RP** to Purchasing on a purchase requisition form. **RP's will not be able to order any of the controlled items utilizing the Procurement Card Program for small orders.** The controlled items on the purchase requisition form must be highlighted and followed by a statement that the item ordered is a controlled item. The location of use or storage of the item must be included on the purchase requisition form. Furnishing these items of information to Purchasing will enable them to maintain the records as required.

## **D. Surplus Property**

The University will not place any of the controlled items on the MOU list into surplus property sales. Any **RP** wishing to dispose of controlled items should contact the Environmental Health & Safety Office. All precursor chemicals will be disposed of through the University's hazardous waste program; any laboratory apparatus listed on the MOU will be destroyed by EH&S. The Supervisor of the University's Surplus Property will inform the Environmental Health & Safety Office (EH&S) of all sales at least two weeks in advance. The EH&S Office will send a representative to Surplus Property in order to identify any items included on the MOU list. These items will be picked up by EH&S personnel and disposed of properly.

## **E. Security Procedures Governing Use of Controlled Items**

Controlled item security consists of site security, operational security, written inventory monitoring log, updated, and loss reporting procedures. The responsible individual is also required to provide means by which the controlled items can be stored in accordance with recommendations of the manufacturer and the Texas Natural Resource Conservation Commission (TNRCC). The procedures for storage and handling of controlled items must also adhere to all applicable state and federal laws.

## **F. Site Security**

The University of Texas at Arlington Police Department is available to assist in evaluating and making recommendations regarding site security.

1. Specific locations (e.g., a laboratory or storage area assigned to the **RP**) should be established where controlled items are utilized and/or stored.

2. All doors and windows must be locked when any room containing controlled items (or any rooms providing access to such a room) is not occupied.
3. Access to rooms containing controlled items must be restricted to personnel so authorized by the **RP**, and key control must be established so that only those so authorized can have access to the site. University Key Control Services stands ready to assist the **RP** in establishing assurance over keyed access to their assigned laboratories or storage areas.

## **G. Operational Security**

1. Written procedures must be established by each **RP** to assure the proper use of controlled items in laboratories and storerooms. These procedures should be available for inspection by DPS and EH&S personnel at any time.
2. Personnel authorized by the **RP** to use, handle, or store the controlled items must be alert to any unauthorized personnel entering laboratories containing controlled items, and appropriate actions must be taken to assure the security of the controlled items when visitors are present.

## **H. Inventory and Reporting of Loss**

1. Written prudent procedures must be established by the **RP** to monitor quantitatively the consumption and use of the controlled items. These procedures should be available for inspection by DPS and EH&S personnel at any time.
2. Personnel authorized by the **RP** to use, handle, or store the controlled items must be alert and attentive to the disappearance of any controlled items and to report losses to the UTA Police Department immediately (within the next business day) upon the discovery of the loss.

## **I. Designation of a University Liaison**

The Chief of Police of the University of Texas at Arlington is designated as the liaison between the Department of Public Safety and the University, and the DPS has been so informed.

The memorandum from the Provost as well as the Memorandum of Understanding signed by the Texas Department of Public Safety and the Texas Higher Education Coordinating Board are available for review in the Environmental Health & Safety Office.

# 10. CHEMICAL WASTE

## A. HAZARDOUS WASTES

A hazardous waste is a waste that can, by U.S. Environmental Protection Agency definition, pose a substantial threat or potential hazard to human health or the environment.

Types of hazardous wastes include certain listed wastes, as well as wastes that exhibit the characteristics of ignitability, corrosivity, reactivity, or toxicity. (See APPENDIX V for waste definitions and example lists.)

Always contact the Environmental Health and Safety Office before assuming a waste is not regulated. Do not depend upon the information from Material Safety Data Sheets (MSDS) because state and local regulations may not be taken into account in the preparation of MSDS.

## B. REGULATED WASTES

There are many wastes not defined as hazardous wastes that are regulated by state and local agencies. Questions regarding disposal of any waste other than normal "household" trash should be directed to the Hazardous Materials Section of the Environmental Health and Safety Office at 2185.

## C. GAS CYLINDERS

The disposal of gas cylinders can be extremely difficult and expensive. Many gas distributors take back used cylinders, other than lecture bottles. However, the protective caps must be in place. It is illegal to transport cylinders without them. Demurrage is paid for cylinders until they are returned. Prompt return of cylinders lowers demurrage costs.

An old gas cylinder may become dangerous due to valve deterioration (especially if it contains a corrosive gas). Such cylinders may be unsuitable for transport and need to be disposed of by a specialist. Unknown gas cylinders also require specialized handling. Problems created by aged and unknown cylinders are risky and expensive to resolve. A good rule of thumb is to return cylinders as soon as possible after they are depleted and to keep a cylinder no longer than three years. Return all cylinders containing corrosive or reactive gases (e.g. ammonia, chlorine, hydrogen chloride, ethylene oxide, silane, phosphine, or arsine) within one year whether the entire contents have been used or not. Many companies will not refund deposits or may not even accept a cylinder for return if it has been on-site over one year. Lecture bottles are usually sold outright and their purchase is no longer allowed under University policy. Gases should be purchased in larger quantities in cylinders that can be returned.

Cylinders must not be disposed of with normal trash. Lecture bottles that cannot be returned may need to be disposed of as hazardous waste unless it can be proven that they are empty. Avoid doing business with companies that will not accept the return of used cylinders. Control your inventory to avoid unknown and deteriorated cylinders.

The EH&S Hazardous Materials Section can dispose of many varieties of gases if they cannot be returned to the manufacturer. For a partial list of what this office can handle, see the cylinder list in APPENDIX IV.

## D. CONTAINERS

Disposal procedures for empty containers depends on the previous contents and the efficiency of

emptying them. Containers of pourable contents must be completely emptied, i.e., no significant amount of the contents remains. Containers of thick or solidified materials must be scraped out or drained until no more than one inch of material remains in the bottom of the container or no more than 3% of the original weight of the contents remains. Chemical containers that meet these criteria are considered empty and may be disposed of through normal trash collection procedures, given the following provisions:

- if the container labels are removed or made unreadable by painting over or affixing an "Empty" sticker over the previous label (stickers are available from EH&S) and
- if the sole active ingredient of the previous contents was not acutely hazardous (see list of acutely hazardous waste in APPENDIX VI).

**Note:** Containers in excess of 20 gallons must be disposed by the EH&S Hazardous Material Section.

If containers are not or cannot be emptied or if they contain acutely hazardous waste, submit them to the EH&S Hazardous Materials Section as waste, in accordance with the procedures described in this manual. You can also utilize a used container to hold waste for pick-up if the waste is compatible with the residue in the container and the container is in good condition and not leaking.

## **E. BROKEN GLASSWARE**

In most cases chemical residue on broken glassware does not constitute contamination. However, broken glassware should be handled as described under "sharps" in the following chapter if it may be capable of transmitting infectious disease. Non-contaminated broken glassware must be placed into the puncture-resistant containers that are provided and disposed of by Physical Plant Custodial Services. Please contact a supervisor in Custodial Services (2602) to obtain the "glass only" puncture-resistant containers.

## **F. PCB LIGHT BALLASTS**

Commercial PCBs (polychlorinated biphenyls) are mixtures that were once widely manufactured by combining chlorine gas, iron filings, and biphenyls. Their high stability contributes to their intended commercial applications and their long-term adverse environmental and health effects. PCBs are useful as insulators in electrical equipment because they are electrically nonconductive. Their distribution has been limited since 1976.

Any person who encounters a leaking light ballast should follow these procedures: Avoid contact with the leaking liquid, cover items located under the leaking ballast with plastic (a garbage bag), remove non-essential people from the room, ventilate the area and immediately notify the Environmental Health and Safety Office (EH&S) at 2185, and Physical Plant, 3571.

All ballasts not marked "NO PCBs" should be assumed to contain PCBs and placed into the drums designated for PCB light ballasts. The marking must appear on the original manufacturer's label, not written on or added to the label after manufacturing.

All PCB-containing ballasts should be inspected for "leakers". "Leakers" are ballasts that may have PCBs or tar (asphalt that can contain PCBs) leaking from the interior of the capacitor onto the outside of the ballast. PCBs are clear or yellow, while the tar is black. A leak of either or both should be considered a leak of PCBs unless the ballast is labeled "NO PCBs".

If a PCB ballast is leaking, both the fixture and ballast should be left in place. The electrician, while

wearing rubber gloves, should cut and cap the power wire. The fixture should then be marked. If the ballast is leaking out of the fixture, cover items below the fixture with plastic and block off the area of the spill. The electrician should then contact the Environmental Health and Safety Office (EH&S) Hazardous Materials Section (2185). The electrician will need to be present when the EH&S response team arrives.

All ballasts containing PCBs should be packed immediately into DOT-approved steel drums approved for transporting hazardous solids. All drums will be furnished upon request by EH&S. All ballasts marked "NO PCBs" on the original manufacturer's label must be disposed of by EH&S, Hazardous Materials Section.

**Note:** In the case of large ballast removal jobs, prior notification is required for delivery of more than one drum.

## **G. BATTERIES**

Alkaline batteries should be disposed of through normal trash collection procedures. These batteries do not have sufficient contaminants to treat satisfactorily. NiCad rechargeable, lead acid, lithium, and mercury batteries should all be disposed of through EH&S. Metals in these batteries will be reclaimed when processed using the waste disposal procedures in this manual.

## **H. USED OIL AND FILTERS**

Used oils and oil filters from shops or laboratories should be disposed of through EH&S. We first determine whether these materials are hazardous, then we ship off site for recycling or re-refining.

## **I. EXPLOSIVES**

EH&S will dispose of explosive or potentially explosive materials. Use the request procedures outlined in the manual. Some of these materials may be left on site for stabilization before transport to the Hazardous Materials Section's accumulation facilities. Pick-ups of explosives will not be done on the same schedule or with the same frequency as other chemical waste. A partial list of explosive or potentially explosive chemicals is in APPENDIX III.

## **J. RADIOACTIVE WASTE**

The disposal of radioactive waste is governed by a number of government statutes and regulations. Before attempting to dispose of any such waste, contact both the EH&S Radiation Section and the EH&S Hazardous Materials Section for special instructions. Required training related to radioactive materials and the Radiation Safety Manual is available by calling the Radiation Safety Section of the Environmental Health and Safety Office at 2185.

## **K. FLUORESCENT LAMPS**

Fluorescent and high-intensity discharge (HID) lamps contain a small quantity of mercury that can be harmful to the environment and to human health when improperly managed. Mercury is regulated under the Resource Conservation Recovery Act (RCRA), which is administered by the EPA. Under current law, mercury-containing lamps, such as fluorescent and HID lamps, may be regulated as hazardous waste.



The EH&S Hazardous Materials Section manages all fluorescent and HID lamps through recycling. Recycling allows the mercury to be separated from the glass, aluminum and other lamp components, and all material is reused in manufacturing other products.

In the event that you have a broken lamp in your area, notify EH&S, and a member of the Hazardous Materials Section will then clear your area of the broken glass, aluminum, and mercury.

If you have any question, or need to arrange a pick-up, contact the EH&S Hazard Materials Section, 2185.

# 11. Special Wastes

Special waste is comprised of the following: sharps, animal waste, microbiological waste, blood and blood products, and pathological waste. Special waste is regulated by the Texas Natural Resource Conservation Commission and the Texas Department of Health.

## Record Keeping

All lab personnel who treat and dispose of microbiological waste or bedding of animals exposed to pathogens on site in accordance with the guidelines described in sections A & B below, must keep the following records.

- a. A lab that generates 50 pounds or less per calendar month of these wastes must record the following:
  1. date of treatment
  2. amount of waste treated
  3. method/conditions of treatment
  4. name (printed) and initials of person(s) performing treatment
- b. A lab that generates more than 50 pounds per calendar month of these wastes must record the following:
  1. all of the above with the addition of:
  2. a written procedure for the operation and testing of any equipment used and a written procedure for the preparation of any chemicals used in treatment.

## A. MICROBIOLOGICAL WASTE

Microbiological waste includes:

- a. discarded cultures and stocks of infectious agents and associated biologicals
- b. discarded cultures of specimens from medical, pathological, pharmaceutical, research, clinical, commercial, and industrial laboratories
- c. discarded live and attenuated vaccines, but excluding the empty containers thereof
- d. discarded, used disposable culture dishes
- e. discarded, used disposable devices used to transfer, inoculate, or mix cultures

Acceptable methods of treatment and disposal of microbiological waste at the University include:

### Steam Sterilization

- a. temperature of at least 121°C

- b. pressure of at least 15 pounds per square inch
- c. time of at least 30 minutes

### **Chemical Disinfection**

- a. Use a chemical agent that is registered with the EPA as a disinfectant and in accordance with the manufacturer's instructions
- b. Immerse the waste for not less than three minutes in:
  - 1. a freshly prepared solution of household bleach diluted 1:10 with water
  - or
  - 2. a solution of 70% by volume 2-propanol (isopropyl alcohol)
- c. Waste that has been immersed in a liquid disinfectant must be thoroughly drained before disposal.

or

### **Disposal of Microbiological Waste**

Microbiological waste which has been treated in accordance with the methods described above can be disposed of through the regular trash as long as the following procedures are followed:

- a. Place a label on the original bag or container stating "treated in accordance with 1.136 of the TAC SWFHCRF" (available from EH&S, Hazardous Materials Section),  
and
- b. Place the bag or other container into another bag or container that is a different color and is opaque, e.g., a black trash bag.

**Note:** If you are not able to treat and dispose of microbiological waste yourself, contact EH&S for assistance. Also, if treated waste is in a liquid form it can be disposed of through the sanitary sewer.

**Note:** In vitro tissue cultures that have not been intentionally exposed to pathogens are exempt from these regulations.

### **Incineration**

The incinerator is located on the roof of the Life Science Building. Following are record-keeping and operational procedures for the use of the incinerator.

- 1. Prior to incineration of any material, the following information must be entered in the Log Books located in the Biology or Psychology Offices
  - Date and time
  - Weight and type of material
  - If material is radioactive, you must record approximate activity

- Print name and initial entry
2. This incinerator is designed to destroy up to 100 pounds per hour of special waste. **DO NOT OVERLOAD THE INCINERATOR!**
  3. Operate during daylight hours only.
  4. Do not burn aerosol cans, closed containers, or flammable liquids.
  5. Do not attempt to burn paper such as office records, computer paper, or telephone books.
  6. Preheat the incinerator by setting the timer for approximately 30 minutes prior to use. If the main charging door is opened while the incinerator is operating, the primary burner will be shut off by the door safety switch.
  7. Load waste into the incinerator. Make sure that all waste is on the burning chamber hearth and not on the door block. Close the door, set the timer for a minimum of two hours, and let it burn down.
  8. Do not open the door or add more trash until the load has burned down. This could cause two problems: 1) overloading of the incinerator; and 2) the possibility of explosion which could injure the operator.
  9. Open the door and load the next load. Close the door and set the timer.
  10. If ashes build up above the bottom of the burner port or obstruct air passages, contact Environmental Health & Safety
  11. Do not use water to cool hot refractory or brick.

## **B. BEDDING OF ANIMALS EXPOSED TO PATHOGENS**

All bedding of animals exposed to pathogens should be disposed of in the incinerator located on the roof of the Life Science Building. If you need special assistance regarding incineration, contact the EH&S Office, 2185.

## **C. ANIMAL WASTE**

Animal waste includes carcasses of animals, body parts of animals, and blood and blood products from animals.

- a. All animals and animal parts must be double bagged to prevent leakage and transported to the incinerator located on the roof of the Life Science Building. If you need special assistance regarding incineration, contact the EH&S Office, 2185.
- b. All animal blood and blood products should be disposed of by incineration, following the above procedures.

## **D. BLOOD AND BLOOD PRODUCTS**

Blood and blood products include all waste bulk human blood, serum, plasma, and other blood

components. All human blood and blood products should be transported in leak-proof containers to the incinerator located on the roof of the Life Science Building. If you need special assistance regarding incineration, contact the EH&S Office, 2185.

## **E. PATHOLOGICAL WASTE**

Pathological waste includes human materials such as tissues and body parts, laboratory specimens of blood and tissue after completion of laboratory examination, and anatomical remains, and must be incinerated.

## **F. SHARPS**

Sharps considered special waste include hypodermic needles, hypodermic syringes with attached needles, scalpel blades, razor blades, disposable razors, and Pasteur pipettes. Broken glassware is also treated as special waste if it may be capable of transmitting infectious disease. (If glassware is not potentially infectious, see sections concerning "containers" and "broken glassware" in the preceding chapter entitled "Chemical Waste." All of the above shall be disposed of as infectious waste and deposited into the sharps containers available through EH&S. These containers will be kept in each work area that generates sharps.

- a. To avoid accidental sticks, hypodermic needles must be placed directly into the containers and not recapped, bent, broken, clipped, or removed from disposable syringes.
- b. Do not attempt to treat (decontaminate) sharps yourself for any biohazard. However, all regulated sharps must be as free of chemicals as possible.
- c. Contact EH&S to obtain sharps containers and instructions for their use, and to schedule pickup of full containers. In order for the containers to be picked up, a request form must be sent to the EH&S.
- d. Do not allow the containers to become overfilled.
- e. Do not dispose of these containers with the regular trash.
- f. Do not incinerate sharps containers.

# 12. Disposal

## A. SANITARY SEWER DISPOSAL

Drain disposal of chemicals into the sanitary sewer system is permitted only for small amounts of substances that can be successfully treated by the local Wastewater Treatment Facilities and must be in compliance with the guidelines set forth by the University's Environmental Health and Safety Office.

Hazardous wastes (see APPENDIX V for definition) must **NOT** be disposed of in any quantity by pouring down the drain. Do not dispose of the following materials in the sanitary sewer (sink or other drains):

1. FLAMMABLE AND COMBUSTIBLE SOLVENTS including benzene, toluene, xylenes, hexane, acetone, ethers, formaldehyde, tetrahydrofuran, and ethyl acetate.
2. HALOGENATED SOLVENTS including chloroform, dichloromethane, carbon tetrachloride, and chlorinated fluorocarbons.
3. PHENOLIC AND AMINE COMPOUNDS including phenols, hydroquinone, acrylamide, and ethanolamine.
4. CORROSIVE MATERIALS including sulfuric acid, hydrochloric acid, acetic acid, sodium hydroxide, and potassium hydroxide.
5. AQUEOUS SOLUTIONS containing regulated quantities of arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc.
6. CYANIDE AND SULFIDE COMPOUNDS including organic nitriles and mercaptans.
7. POISONS including bromine, ethidium bromide, benzidine, and osmium tetroxide.
8. EXPLOSIVE COMPOUNDS including picric acid and organic peroxides (see APPENDIX III for other examples).
9. COMMERCIAL PRODUCTS including strippers, paints, dyes and some concentrated cleaners.
10. RADIOACTIVE MATERIALS

If you have any questions about sink disposal of any material, contact the **Hazardous Materials Section**, of the Environmental Health and Safety Office (2185) for assistance. Violations of the City of Arlington wastewater discharge permit or other waste disposal regulations could result in **financial penalties, interruption of laboratory activities, or prison sentences.**

## B. STORM SEWER DISPOSAL

The storm sewer system is designed to carry run-off from rain to local creeks and other waterways. The inlets to this system are frequently at curbs and low outdoor areas such as loading dock ramps. Some older buildings also have basement drains connected to the storm sewer system. If you are not sure whether a drain is connected to the storm or sanitary sewer system, contact the Environmental Health &

Safety Office, 2185.

Drain disposal of chemicals, products, or other substances to the storm sewer system is NOT permitted under any circumstances.

## **C. CONTAINERS**

Containers holding waste must be in good condition, not leaking, and compatible with the waste being stored. The container must always be closed during storage, except when it is necessary to add waste. Hazardous waste must not be placed in unwashed containers that previously held an incompatible material (see Incompatibility chart in APPENDIX II).

If a container holding hazardous waste is not in good condition or if it begins to leak, the generator must transfer the waste from this container to a container that is in good condition. Please contact the EH&S Hazardous Materials Section, Ext. 2185, if assistance is required.

The EH&S Hazardous Materials Section will provide 10-liter Nalgene containers for laboratories generating large quantities of liquid hazardous waste.

A storage container holding a hazardous waste that is incompatible with any waste or other materials stored nearby in other containers must be separated from the other materials or protected from them by means of a partition, wall or other device.

### **All waste containers must be:**

1. Marked with the words "hazardous waste" and their contents indicated. An EH&S Hazardous Waste Inventory Tag must be used to list the contents. Deface or remove any old labels.
2. Kept at or near (immediate vicinity) the site of generation and under control of the generator.
3. Compatible with contents (i.e. acid should not be stored in metal cans).
4. Closed at all times except when waste is being added to container.
5. Properly identified with completed waste tags before pickup is requested.
6. Safe for transport with non-leaking screw-on caps.
7. Filled to a safe level (not beyond the bottom of the neck of the container or a 2-inch head space for 55 gallon drums). Over-filled bottles are:
  - a. hard to pour safely,
  - b. inclined to burst,
  - c. apt to leak, and
  - d. capable of endangering the technician through splashing or shooting up into one's face upon opening.

## **D. ACCUMULATION**

A generator of possible hazardous waste may accumulate up to a total of 55 gallons of waste, which may be determined to be hazardous by Environmental Health and Safety, or one quart of "listed" acutely hazardous waste (see APPENDIX VI) at or near the point of generation. If a process will generate more than this volume at one time, the Environmental Health and Safety Office should be contacted in advance to arrange a special waste pick-up.

Whenever possible, keep different hazardous wastes separate so that disposal options remain clearer and more cost effective. In all cases, do not mix incompatible wastes or other materials (see APPENDIX II) in the same container or place wastes in an unwashed container that previously held an incompatible waste or material. However, if separation is not practical, collect waste in compatible containers and try to keep it segregated into the following categories:

1. Miscellaneous solids, e.g., gloves, rags or towels, and other lab equipment should be collected separately from liquid wastes.
2. Halogenated solvents, e.g., methylene chloride, chloroform, carbon tetrachloride.

**Note:** Disposal of non-halogenated solvents contaminated with halogens costs 4-5 times as much as non-halogenated solvents.

3. Non-halogenated solvents, e.g., xylene, toluene, alcohols.
4. Waste oil must be kept as uncontaminated as possible in order to be recycled. You should keep oils separate from other chemicals, particularly solvents, pesticides, and PCB's.
5. Acids
6. Bases
7. Metal-bearing waste whether dry, flammable, corrosive or other. Specific metals of concern are arsenic, barium, cadmium, chromium, lead, mercury, nickel, selenium, silver, and thallium.
8. Accumulate waste that is both flammable and corrosive separately from waste that is either flammable or corrosive.
9. Special wastes, e.g., cyanide, sulfide, pesticides, oxidizers, organic acids, explosives and peroxides, should be collected individually whenever possible.

## E. CONTAINER LABELING

Before chemical waste can be picked up by EH&S, a Hazardous Chemical Inventory Tag (see APPENDIX-IX) is required. It should be filled out by the waste generator and attached to each container. The information on the tag is used to categorize and treat the waste. Please fill it out legibly, accurately and completely. (SEE APPENDIX IX-a for a sample filled-out tag). Include the following information:

**Date** - Date waste was generated.

**Principal Investigator** - Name of the individual responsible for supervising the process generating the waste.

**Building, Room No. and Phone No.**



**Indicate Overall Volume or Weight** - Write in the total volume or weight of material in this container.

**Specify Chemical Contents** - Specific, full chemical name (no formulas or abbreviations) for each chemical constituent in this container. Product names or trade names are acceptable if the manufacturer's name and address or a material safety data sheet can be supplied with the material. Vague statements such as "hydrocarbons", "organic waste", "various salts of \_\_\_\_" make it impossible to comply with EPA treatment standards and will delay the pick-up until sufficiently detailed information is submitted to EH&S.

**Amount**- Total volume or weight of each chemical constituent in the container.

**Vol. %**- Percentage of the total volume to which each chemical amount is equal (should add up to 100%) or the actual weight or volume of each constituent.

**Note:** Biological Waste and Sharps containers do not require Chemical Inventory Tags.

## F. REQUEST FOR DISPOSAL

When your container is ready for disposal and is properly tagged, contact the Hazardous Materials Section of the Environmental Health & Safety Office by sending a Request for Disposal (see APPENDIX VIII for example of a "Request for Disposal - Hazardous Chemicals" and APPENDIX VII for example of a "Request for Disposal - Biological Waste or Sharps.":

1. via Campus Mail to:

Hazardous Materials Section  
Environmental Health & Safety  
Box 19257

or

2. hand deliver to:

Hazardous Materials Section  
Environmental Health & Safety  
500 Summit Avenue (formerly Human Resources Bldg.)

or

3. via Fax to:

Hazardous Materials Section  
Environmental Health & Safety  
272-2144

at least five working days prior to reaching the accumulation limits referenced in Section D above.

The EH&S makes pickups daily and will come to your site as quickly as possible. The information for each container listed on the request form must be identical to the information on the Hazardous Chemical Inventory Tag on the container. (See APPENDIX IX; APPENDIX IX-a is a sample filled-out form.) Include the following information on a Request for Disposal - Hazardous

Chemicals form:

**Facility** - Check the appropriate facility.

**Name** - Name of the individual responsible for supervising the process of generating the waste. Must be a UT employee.

**Department** - Name of department generating the waste.

**Box No.** - 5 character code for campus mail. See the front of the UT Phone Directory for listing.

**Phone Number** - Phone number of person to contact regarding waste pickup.

**Alternate Contact** - Name of individual to contact if primary contact is not available.

**Alternate Phone** - Phone number of alternate contact.

**Location of Pickup** - Building and room number where the waste is located.

**Contents** - List the chemical constituents for each container. Use specific, full chemical name, no formulas or abbreviations. Product names or trade names are acceptable if the manufacturer's name and address or a material safety data sheet can be supplied with the material. Vague statements such as "hydrocarbons", "organic waste", "various salts of \_\_\_\_\_" make it impossible to comply with EPA treatment standards and will delay the pick-up until sufficiently detailed information is submitted to EH&S.

**Percentage %** - Percentage of the total volume in each container to which each chemical amount is equal (percentages for each tag number should add up to 100%).

**Amount** - Total volume or weight of each chemical in the container.

**Physical State** - Indicate if the material is a solid (S) or liquid (L).

**Signature** - Signature of individual responsible for supervising the process of generating the waste, stating that the materials listed are fully and accurately described and are packaged and labeled according to EH&S procedures. Must be a UT employee (e.g., faculty, staff, TA, or RA).

**Date** - Date that the form was signed and routed to the EH&S.

Biological waste or sharps requests for disposal should be completed by following the instructions on that form (see APPENDIX-VII).

# 13. Pollution Prevention

## A. GENERAL INFORMATION

There are two primary types of pollution prevention: source reduction and waste minimization. **Of these two approaches source reduction is always preferred from an environmental perspective.** Source reduction includes any activity that reduces or eliminates the generation of hazardous waste at the source or the release of a pollutant or contaminant, usually within a process. The best way to limit or eliminate the need for and cost of hazardous waste disposals is to limit or eliminate processes that generate such waste or substitute less toxic but still effective compounds. Becoming aware of problems and alerting others is a good first step. For starters, ask yourself these questions:

1. **Am I buying wisely?** Remember that disposal costs are sometimes more than the original purchase price for many chemicals and are funded by research overhead. Bulk purchases of chemicals are not a good deal if excess stock is given up for disposal.
2. **Am I rotating my stock** to avoid outdated chemicals?
3. **Am I properly storing** my chemicals to prevent aging or, worse yet, spills and fires?
4. **Do people in my lab know what to do** in the event of a spill to minimize personal danger and the volume of waste material generated as a result of such spills?
5. **Am I planning** experiments with **waste minimization** in mind?
6. **Can I substitute** less hazardous materials during any step of an experiment?
7. **Do people** in my lab even **know what is** and **what isn't a "hazardous chemical"**?
8. **Does the protocol** in my lab **include** proper **waste segregation** and **containerization** so that disposal options can remain clearer and more cost effective?
9. **Are the facts on my waste forms true** and **complete**?
10. **Do I prevent "unknowns"** by keeping containers labeled?
11. **Do I ever look internally** for a **needed chemical** before buying a fresh bottle?
12. **Have I explored** possible **new procedures** and/or **equipment modifications** aimed at reducing waste generation?
13. **Do I have other ideas?** Have I shared them?

## B. SPECIAL OPTIONS FOR EDUCATIONAL INSTITUTIONS

Pollution prevention options available can be classified into three general groups for further discussion. These waste reduction methods are improved material management practices, improved laboratory practices, and improved practices in other departments.

### Improved Material Management Practices

1. **A centralized purchasing program should be established.** This program should monitor requests for chemicals, and implement policies. These policies would include staggered deliveries, sharing of chemicals between common users, arranging with instructors and investigators to purchase part of their request if the quantities seem excessive, and arrange for partial shipment with the remainder shipped on an as-needed basis. The program should include plans for leftover chemicals.
2. **Order reagent chemicals in exact amounts to be used.** Do not order extra chemical quantities to take advantage of unit cost savings. The net savings will be lost due to eventual disposal costs if the chemical is not used.
3. **Encouraging chemical suppliers to become responsible partners in a waste minimization program** by ordering chemicals from suppliers who will provide quick delivery of small orders and will accept return of unopened stock.
4. **Establish an inventory control program that can trace usage** from purchase to consumption. This will promote sharing of chemicals between common users, provide data on the location of extremely hazardous chemicals, identify the high volume users, locate caches of unused reagents, and delineate where waste reduction options need to be implemented. Reagent chemicals having remaining shelf-life can be monitored for approaching expiration. The inventory can be computerized or kept on a card filing system.
5. **Rotate chemical stocks** using chemicals before their shelf life expires (first-in-first-out stock usage).
6. **Develop a running inventory of unused reagent chemicals** for use by other laboratories or faculty. The inventory control program should extend to all laboratories, including those of individual professors.
7. **Appoint or hire a safety and waste management officer** for each department to work with the Environmental Health and Safety Office. Centralizing responsibilities will facilitate a co-ordinated and efficient implementation of regulations, institution policy and waste reduction goals.
8. **Educate professors, students and staff on the benefits of waste reduction.** This should include instruction on specific techniques for reducing waste generation.
9. **Establish annual goals for institution-wide and departmental waste reduction.** First determine past yearly totals of waste generation, then assess economic and technical feasibility for establishing and achieving specific reduction goals.
10. **Provide routine self-audits** for laboratories, professors, students and staff to minimize reagent accumulation and maximize recycling.

## Improved Laboratory Practices

1. Substitute less hazardous chemicals in experiments. For example: substitute sodium hypochlorite for sodium dichromate; use alcohol for benzene; substitute cyclohexane for carbon tetrachloride in the standard qualitative test for halide ions; stearic acid can replace acetamide in phase change and freezing point depression experiments; and use 1,1,1-trichloroethane instead of carbon tetrachloride and/or chloroform. A number of laboratories are using detergents, potassium hydroxide, or sonic baths as substitutes for the chromic acid solutions used to clean

glassware.

2. **Pre-weigh chemicals for undergraduate usage.** This will reduce spills and other wastes generated by students performing their own weighing. It will also increase laboratory productivity by reducing lab time per student.
3. **When cleaning with solvents, reuse the spent solvent** for the initial cleaning of subsequent articles and use fresh solvent only for the final rinsing. This reuse will decrease the amount of reagent solvent used.
4. **Platinum, palladium, and rhodium contained in catalysts can be recovered** using chemical procedures specific to the particular metals. Segregate these wastes so that off-site recycling may be possible.
5. **Investigate if unused reagent chemicals and their containers can be returned** to the manufacturer. Sealed bottles of stable chemicals may be reusable by the supplier.
6. **Destroy wastes as an integral step in experiments.** This will reduce the need for off-site disposal. If done in undergraduate laboratories, it will develop in students an awareness of proper waste management and waste reduction. Some chemical wastes can be destroyed as a step in experiments.
7. **Keep individual waste streams segregated.**
  - a. Keep hazardous waste segregated from nonhazardous waste. All waste contaminated with a hazardous substance must be treated as hazardous waste.
  - b. Keep recyclable waste segregated from non-recyclable waste.
8. **Ensure that the identity of all chemicals and wastes is clearly marked** on all containers. When researchers leave an institution, they often leave laboratory chemicals behind. These include unused reagent chemicals, unlabeled containers, and an assortment of mixtures and solutions. Unlabeled containers present a particularly troublesome waste management problem since unidentified wastes cannot legally be shipped for disposal and analysis is very costly. It is also a violation of the Texas Hazard Communication Act to store any chemicals in unmarked containers.

## Improved Practices in Other Departments

1. **Replace oil-based paints with water-based paints in art instruction and maintenance operations.** Non-toxic (solvent, lead, and chrome- free) paints should be used wherever possible.
2. **Modify spray-painting techniques** to reduce paint waste. Set the correct air pressure for the spray gun and use the following stroking technique: 1) overlap the spray pattern by 50%, 2) maintain a distance of 6 to 8 inches from the workplace, 3) hold the gun perpendicular to the surface, and 4) trigger the gun at the beginning and end of each stroke.
3. **Reduce generation of pesticide waste** by reducing pesticide application, using non-chemical pest control methods, and preparing and using only the required minimum quantity of pesticide for the job. Investigate the use of irrigation injection of pesticides through the sprinkler system (with

back flow protection), or the use of dry pesticides that are spread on the grounds and watered into the ground. This practice will eliminate the need for pesticide spraying operations and the resulting contaminated wash water.

4. **Collect waste oil and solvents for recycling.** Segregate recyclable oils and solvents from non-recyclable wastes.
5. **Use biodegradable aqueous or detergent cleaners** in place of more hazardous toxic solvents.
6. **Provide training in hazardous waste management practices** for students in departments/courses that generate waste and facilities management/maintenance personnel.

# References

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12. National Research Council. Prudent Practices in the Laboratory, Handling and Disposal of chemicals, 1995.

# **A P P E N D I X**

- I            Sample MSDS**
- II            Examples of Potentially Incompatible Waste**
- III           List of Explosives**
- IV           Lecture Bottles and Cylinders**
- V            Definition of Hazardous Waste**
- VI           List of Acutely Hazardous Chemicals**
- VII          Request for Disposal - Biological Waste and Sharps**
- VIII        Request for Disposal - Hazardous Chemicals**
- VIIIa       Sample of Completed Request for Disposal - Hazardous Chemicals**
- IX           Hazardous Chemical Inventory Tag**
- IXa          Sample of Completed Chemical Inventory Tag**
- X            Laboratory Safety Evaluation**



**1 - PRODUCT IDENTIFICATION**

PRODUCT NAME: ACETONE

FORMULA: (CH<sub>3</sub>)<sub>2</sub>CO

FORMULA WT: 58.08

CAS NO.: 67-64-1

NIOSH/RTECS NO.: AL3150000

COMMON SYNONYMS: DIMETHYL KETONE; METHYL KETONE; 2-PROPANONE

PRODUCT CODES: 9010,9006,9002,9254,9009,9001,9004,5356,A134,9007,9005,9005,9008

EFFECTIVE: 08/27/86

REVISION #02

**PRECAUTIONARY LABELLING**

BAKER SAF-T-DATA(TM) SYSTEM:

HEALTH - 1 SLIGHT

FLAMMABILITY - 3 SEVERE (FLAMMABLE)

REACTIVITY - 2 MODERATE

CONTACT - 1 SLIGHT

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

**LABORATORY PROTECTIVE EQUIPMENT**

SAFETY GLASSES; LAB COAT; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER

**PRECAUTIONARY LABEL STATEMENTS**

DANGER

CAUSES IRRITATION

EXTREMELY FLAMMABLE

HARMFUL IF SWALLOWED OR INHALED

KEEP AWAY FROM HEAT, SPARKS, FLAME. AVOID CONTACT WITH EYES, SKIN, CLOTHING. AVOID BREATHING VAPOR. KEEP IN TIGHTLY CLOSED CONTAINER. USE WITH ADEQUATE VENTILATION. WASH THOROUGHLY AFTER HANDLING. IN CASE OF FIRE, USE ALCOHOL FOAM, DRY CHEMICAL, CARBON DIOXIDE - WATER MAY BE INEFFECTIVE. FLUSH SPILL AREA WITH WATER SPRAY.

SAF-T-DATA(TM) STORAGE COLOR CODE: RED (FLAMMABLE)

**2 - HAZARDOUS COMPONENTS**

COMPONENT	%	CAS NO.
ACETONE	90-100	67-64-1

**3 - PHYSICAL DATA**

BOILING POINT: 56 C ( 133 F) VAPOR PRESSURE(MM HG): 181

MELTING POINT: -95 C ( -139 F) VAPOR DENSITY(AIR=1): 2.0

SPECIFIC GRAVITY: 0.79 EVAPORATION RATE: ~10

(H<sub>2</sub>O=1) (BUTYL ACETATE=1)

SOLUBILITY(H<sub>2</sub>O): COMPLETE (IN ALL PROPORTIONS) % VOLATILES BY VOLUME: 100

APPEARANCE & ODOR: CLEAR, COLORLESS LIQUID WITH A FRAGRANT SWEET ODOR.

#### 4 - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (CLOSED CUP: -18 C ( 0 F) NFPA 704M RATING: 1-3-0

FLAMMABLE LIMITS: UPPER - 13.0 % LOWER - 2.6 %

FIRE EXTINGUISHING MEDIA

USE ALCOHOL FOAM, DRY CHEMICAL OR CARBON DIOXIDE.

(WATER MAY BE INEFFECTIVE.)

SPECIAL FIRE-FIGHTING PROCEDURES

FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND

SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE.

MOVE CONTAINERS FROM FIRE AREA IF IT CAN BE DONE WITHOUT RISK. USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL.

UNUSUAL FIRE & EXPLOSION HAZARDS

VAPORS MAY FLOW ALONG SURFACES TO DISTANT IGNITION SOURCES AND FLASH BACK.

CLOSED CONTAINERS EXPOSED TO HEAT MAY EXPLODE. CONTACT WITH STRONG OXIDIZERS MAY CAUSE FIRE.

#### 5 - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE (TLV/TWA): 1780 MG/M<sup>3</sup> ( 750 PPM)

SHORT-TERM EXPOSURE LIMIT (STEL): 2375 MG/M<sup>3</sup> ( 1000 PPM)

PERMISSIBLE EXPOSURE LIMIT (PEL): 2400 MG/M<sup>3</sup> ( 1000 PPM)

TOXICITY: LD<sub>50</sub> (ORAL-RAT)(MG/KG) - 9750

LD<sub>50</sub> (ORAL-MOUSE)(MG/KG) - 3000

LD<sub>50</sub> (IPR-MOUSE)(MG/KG) - 1297

LD<sub>50</sub> (SKN-RABBIT) (G/KG) - 20

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE

VAPORS MAY BE IRRITATING TO SKIN, EYES, NOSE AND THROAT.

INHALATION OF VAPORS MAY CAUSE NAUSEA, VOMITING, HEADACHE, OR LOSS OF CONSCIOUSNESS.

LIQUID MAY CAUSE PERMANENT EYE DAMAGE.

CONTACT WITH SKIN HAS A DEFATTING EFFECT, CAUSING DRYING AND IRRITATION.

INGESTION MAY CAUSE NAUSEA, VOMITING, HEADACHES, DIZZINESS, GASTROINTESTINAL IRRITATION.

CHRONIC EFFECTS OF OVEREXPOSURE MAY INCLUDE KIDNEY AND/OR LIVER DAMAGE.

TARGET ORGANS: RESPIRATORY SYSTEM, SKIN

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: NONE IDENTIFIED

ROUTES OF ENTRY: INHALATION, INGESTION, EYE CONTACT, SKIN CONTACT

#### EMERGENCY AND FIRST AID PROCEDURES

CALL A PHYSICIAN.

IF SWALLOWED, IF CONSCIOUS, IMMEDIATELY INDUCE VOMITING.

IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.

IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. FLUSH SKIN WITH WATER.

#### 6 - REACTIVITY DATA

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: HEAT, FLAME, SOURCES OF IGNITION

INCOMPATIBLES: HALOGEN ACIDS AND HALOGEN COMPOUNDS, STRONG BASES, STRONG OXIDIZING AGENTS, CAUSTICS, AMINES AND AMMONIA,

CHLORINE AND CHLORINE COMPOUNDS,

STRONG ACIDS, ESP. SULFURIC, NITRIC, HYDROCHLORIC

#### 7 - SPILL AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE

WEAR SUITABLE PROTECTIVE CLOTHING. SHUT OFF IGNITION SOURCES; NO FLARES, SMOKING, OR FLAMES IN AREA. STOP LEAK IF YOU CAN DO SO WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. TAKE UP WITH SAND OR OTHER NON-COMBUSTIBLE ABSORBENT MATERIAL AND PLACE INTO CONTAINER FOR LATER DISPOSAL. FLUSH AREA WITH WATER.

J. T. BAKER SOLUSORB(R) SOLVENT ADSORBENT IS RECOMMENDED FOR SPILLS OF THIS PRODUCT.

#### DISPOSAL PROCEDURE

DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

EPA HAZARDOUS WASTE NUMBER: U002 (TOXIC WASTE)

## 8 - PROTECTIVE EQUIPMENT

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS.

RESPIRATORY PROTECTION: RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS UP TO 5000 PPM, A GAS MASK WITH ORGANIC VAPOR CANNISTER IS RECOMMENDED. ABOVE THIS LEVEL, A SELF-CONTAINED BREATHING APPARATUS WITH FULL FACE SHIELD IS ADVISED.

EYE/SKIN PROTECTION: SAFETY GLASSES WITH SIDESHIELDS, BUTYL RUBBER GLOVES ARE RECOMMENDED.

## 9 - STORAGE AND HANDLING PRECAUTIONS

SAF-T-DATA(TM) STORAGE COLOR CODE: RED (FLAMMABLE)

### SPECIAL PRECAUTIONS

BOND AND GROUND CONTAINERS WHEN TRANSFERRING LIQUID. KEEP CONTAINER TIGHTLY CLOSED. STORE IN A COOL, DRY, WELL-VENTILATED, FLAMMABLE LIQUID STORAGE AREA.

## 10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

### DOMESTIC (D.O.T.)

PROPER SHIPPING NAME ACETONE  
HAZARD CLASS FLAMMABLE LIQUID  
UN/NA UN1090  
LABELS FLAMMABLE LIQUID  
REPORTABLE QUANTITY 5000 LBS.

### INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME ACETONE  
HAZARD CLASS 3.1  
UN/NA UN1090  
LABELS FLAMMABLE LIQUID

## EXAMPLES OF POTENTIALLY INCOMPATIBLE WASTE

Many hazardous wastes, when mixed with other waste or materials, can produce effects which are harmful to human health and the environment, such as (1) heat or pressure, (2) fire or explosion, (3) violent reaction, (4) toxic dusts, mists, fumes, or gases, or (5) flammable fumes or gases.

Below are examples of potentially incompatible wastes, waste components, and materials, along with the harmful consequences which result from mixing materials in one group with materials in another group.

This list is not intended to be exhaustive. A waste generator must, as the regulations require, adequately control his wastes so that he can avoid creating uncontrolled substances or reactions of the type listed below, whether they are listed below or not.

It is possible for potentially incompatible wastes to be mixed in a way that precludes a reaction (e.g., adding acid to water rather than water to acid) or that neutralizes them (e.g., a strong acid mixed with a strong base), or that controls substances produced (e.g., by generating flammable gases in a closed tank equipped so that ignition cannot occur, and burning the gases in an incinerator).

In the lists below, the mixing of a Group A material with a Group B material may have the potential consequence as noted.

<b>Group 1-A</b> Acetylene sludge Alkaline caustic liquids Alkaline cleaner Alkaline corrosive liquids Alkaline corrosive battery fluid Caustic wastewater Lime sludge and other corrosive alkalies Lime wastewater Lime and water Spent caustic	<b>Group 2-B</b> Other reactive metals and metal hydrides Any waste in Group 1-A or 1-B Potential consequences: Fire or explosion; generation of flammable hydrogen gas.
<b>Group 1-B</b> Acid sludge Acid and water Battery acid Chemical cleaners Electrolyte, acid Etching acid liquid or solvent Pickling liquor and other corrosive acids Spent acid Spent mixed acid Spent sulfuric acid	<b>Group 3-A</b> Alcohols Water <b>Group 3-B</b> Any concentrated waste in Groups 1-A or 1-B Calcium Lithium Metal hydrides Potassium SO <sub>2</sub> Cl <sub>2</sub> , SOCl <sub>2</sub> , PCl <sub>3</sub> , CH <sub>3</sub> SiCl <sub>3</sub> Other water-reactive waste Potential consequences: Fire, explosion, or heat generation; generation of flammable or toxic gases.
Potential consequences: Heat generation; violent reaction.	<b>Group 4-A</b> Alcohols Aldehydes Halogenated hydrocarbons Nitrated hydrocarbons Unsaturated hydrocarbons Other reactive organic compounds and solvents
<b>Group 2-A</b> Aluminum Beryllium Calcium Lithium Magnesium Potassium Sodium Zinc powder	<b>Group 4-B</b> Concentrated Group 1-A or 1-B wastes Group 2-A wastes

Potential consequences: Fire, explosion, or violent reaction.

**Group 5-A**

Spent cyanide and sulfide solutions

**Group 5-B**

Group 1-B wastes

Potential consequences: Generation of toxic hydrogen cyanide or hydrogen sulfide gas.

**Group 6-A**

Chlorates  
Chlorine  
Chlorites  
Chromic acid  
Hypochlorites  
Nitrates  
Nitric acid, fuming  
Perchlorates  
Permanganates  
Peroxides  
Other strong oxidizers

**Group 6-B**

Acetic acid and other organic acids  
Concentrated mineral acids  
Group 2-A wastes  
Group 4-A wastes  
Other flammable and combustible wastes

Potential consequences: Fire, explosion, or violent reaction.

Source: "Law, Regulations, and Guidelines for Handling of Hazardous Waste." California Department of Health, February 1975.

# LIST OF EXPLOSIVES

Ammonium nitrate-fuel oil mixture  
Ammonium nitrate, (with more than 0.2 percent combustible substances)  
Ammonium perchlorate  
Ammonium picrate, (dry or wetted with less than 10 percent water, by mass)  
Azodiisobutyronitrile  
Barium azide (dry or wetted with less than 50 percent water, by mass)  
Barium styphnate  
Cyclotetramethylenetetranitramine, desensitized (or) Octogen, desensitized (or) HMX, desensitized  
Cyclotetramethylenetetranitramine, wetted (or) HMX, wetted (or) Octogen, wetted (with not less than 15 percent water, by mass)  
Cyclotrimethylenetrinitramine, desensitized (or) Cyclonite, desensitized (or) Hexogen, desensitized (or) RDX, desensitized, Hexogen, RDX, desensitized  
Cyclotrimethylenetrinitramine, wetted (or) Cyclonite, wetted (or) Hexogen, wetted (or) RDX, wetted (with not less than 15 percent water, by mass)  
Deflagrating metal salts of aromatic nitro derivatives  
2-Diazo-1-Naphthol-4-Sulpho chloride  
2-Diazo-1-Naphthol-5-Sulpho-Chloride  
Diazodinitrophenol, wetted with not less than 40 percent water or mixture of alcohol and water, by mass  
Diethyleneglycol dinitrate, desensitized (with not less than 25 percent non-volatile water-insoluble phlegmatizer, by mass)  
Dinitroglycoluril (or) Dingu  
Dinitrophenol, (dry or wetted with less than 15 percent water, by mass)  
Dinitrophenolates (alkali metals, dry or wetted with less than 15 percent water, by mass)  
Dinitroresorcinol, (dry or wetted with less than 15 percent water, by mass)  
N,N'-Dinitroso-N-N'-dimethyl terephthalamide not more than 72% as a paste  
N,N'-Dinitrosopentamethylenetetraamine not more than 82% with phlegmatizer  
Dinitrosobenzene  
Dipicryl sulfide, (dry or wetted with less than 10 percent water, by mass)  
Guanyl nitrosaminoguanilydene hydrazine, wetted (with not less than 30 percent water, by mass)  
Guanyl nitrosaminoguanilytetrazene, wetted (or) Tetrazane, wetted (with not less than 30 percent water or mixture of alcohol and water, by mass)  
Hexanitrodiphenylamine (Dipicrylamine; Hexyl)  
Hexanitrostilbene  
Hexatonal, cast  
Hexolite, (dry or wetted with less than 15 percent water, by mass)  
Lead azide, wetted (with not less than 20 percent water or mixture of alcohol and water, by mass)  
Lead mononitroresorcinolate  
Lead styphnate, wetted (or) Lead trinitroresorcinolate, wetted (with not less than 20 percent water or mixture of alcohol and water, by mass)  
Mannitol hexanitrate (Nitromannite), wetted (with not less than 40 percent water, by mass or mixture of alcohol and water)  
5-Mercaptotetrazol-1-acetic acid  
Mercury fulminate, wetted (with not less than 20 percent water, or mixture of alcohol and water, by mass)  
Nitro urea  
5-Nitrobenzotriazol  
Nitrocellulose, (dry or wetted with less than 25 percent water [or alcohol], by mass)  
Nitrocellulose, plasticized (with not less than 18 percent plasticizing substance, by mass)  
Nitrocellulose, (unmodified or plasticized with less than 18 percent plasticizing substance, by mass)  
Nitrocellulose, wetted (with not less than 25 percent alcohol, by mass)  
Nitroglycerin, desensitized (with not less than 40 percent non-volatile water insoluble phlegmatizer, by mass)  
Nitroglycerin, solution in alcohol, (with more than 1 percent but not more than 10 percent nitroglycerin)  
Nitroguanidine (or) Picrite, (dry or wetted with less than 20 percent water, by mass)  
Nitrosoguanidine  
Nitrostarch, (dry or wetted with less than 20 percent water, by mass)

## Explosives (continued)

Nitrotriazolone (or) NTO

Octolite (or) Octol, (dry or wetted with less than 15 percent water, by mass)

Pentaerythrite tetranitrate (or) Pentaerythritol tetranitrate (or) PETN, wetted (with not less than 25 percent water, by mass (or) Pentaerythrite tetranitrate (or) Pentaerythritol tetranitrate (or) PETN, desensitized (with not less than 15% Phlegmetizer).

Pentaerythrite tetranitrate (or) Pentaerythritol tetranitrate (or) PETN, (with not less than 7 percent wax by mass)

Pentolite, (dry or wetted with less than 15 percent water, by mass)

Potassium salts of aromatic nitro-derivatives, explosive.

RDX and HMX mixtures, wetted (with not less than 15 percent water by mass) (or) RDX and HMX mixtures, desensitized (with not less than 10 percent phlegmatizer by mass)

Sodium dinitro-o-cresolate, (dry or wetted with less than 15 percent water, by mass)

Sodium picramate, (dry or wetted with less than 20 percent water, by mass)

Sodium salts of aromatic nitro-derivatives, explosive

Tetranitroaniline

Tetrazol-1-acetic acid

Trinitro-meta-cresol

Trinitroaniline (or) Picramide

Trinitroanisole

Trinitrobenzene, (dry or wetted with less than 30 percent water, by mass)

Trinitrobenzenesulfonic acid

Trinitrobenzoic acid, (dry or wetted with less than 30 percent water, by mass)

Trinitrochlorobenzene (or) Picryl chloride

Trinitrofluorenone

Trinitronaphthalene

Trinitrophenetole

Trinitrophenol (or) Picric acid, (dry or wetted with less than 30 percent water, by mass)

Trinitrophenylmethylnitramine (or) Tetryl

Trinitroresorcinol (or) Styphnic acid, (dry or wetted with less than 20 percent water, or mixture of alcohol and water, by mass)

Trinitrotoluene and Trinitrobenzene mixtures (or) Trinitrotoluene (or) TNT and trinitrobenzene mixtures (or) TNT and hexanitrostilbene mixtures and Hexanitrostilbene mixtures

Trinitrotoluene mixtures containing Trinitrobenzene and Hexanitrostilbene (or) TNT mixtures containing trinitrobenzene and hexanitrostilbene

Trinitrotoluene (or) TNT, (dry or wetted with less than 30 percent water, by mass)

Tritonal

Urea nitrate, (dry or wetted with less than 20 percent water, by mass)

Zirconium picramate, (dry or wetted with less than 20 percent water, by mass)



## Lecture Bottles and Cylinders

### Combustible liquid

Tetraphenyl silane (<3"x12")

### Corrosive

Antimony pentachloride (<3"x12")

Antimony pentafluoride (<3"x12")

Antimony tribromide (<3"x12")

Antimony trichloride (<3"x12")

Antimony trifluoride (<3"x12")

Boron tribromide (<3"x12")

Bromine

Hydriodic acid

Hydrogen fluoride

Hydrogen iodide

Molybdenum hexafluoride

Oleum

Silicon tetrabromide

Silicon tetrachloride

Sulfur dibromide

Sulfur dichloride

Sulfur monobromide

Sulfur monochloride

Sulfur oxide (<3"x12")

Sulfur trioxide (<3"x12"/no solids)

Sulfuric acid

Sulfuryl chloride

Tetrachloro silane

Thionyl bromide

Thionyl chloride

Titanium tetrabromide

Titanium tetrachloride

Trichloro n-decyl silane (<3"x12")

Trichloroacetyl chloride

Trichloromethane sulfonyl chloride (<3"x12")

Trichlorophenyl silane (<3"x12")

Trifluoroacetyl fluoride (<3"x12")

Tungsten bromide

Tungsten chloride

Tungsten fluoride

Tungsten hexafluoride

Vanadium oxytrichloride (<3"x12")

Vanadium tetrachloride (<3"x12")

### Flammable gas

Acetyl fluoride (<3"x12")

Acetylene

Butadiene

Butane

Butene

Carbon monoxide

Deuterium

Ethane

Ethylene

Hydrogen

Hydrogen sulfide (<3"x12")

Isobutane

Isobutylene

Mapp gas

Methane

Methyl acetylene

Methyl silane (<3"x12")

Propane

Propylene

Silane (<3"x12")

Tetramethyl silane (<3"x12")

Trichlorosilane (<3"x12")

Trimethyl borane (<3"x12")

Trimethyl chlorosilane (<3"x12")

Trimethyl ethoxy silane (<3"x12")

Trimethyl silane (<3"x12")

### Nonflammable gas

Ammonia

Argon

Carbon dioxide

Chlorine

Deuterium bromide

Deuterium chloride

Deuterium fluoride

Deuterium iodide

Helium

Krypton

Neon

Nitrogen

Nitrous oxide (<3"x12")

Ozone (<3"x12")

Phosphorus trifluoride (<3"x12")

Tetrafluoro silane (<3"x12")

Xenon

## **Oxidizer**

Oxygen

## **Poison**

Antimony triiodide	(<3"x12")
Boron trichloride	(<3"x12")
Boron trifluoride	(<3"x12")
Bromine chloride	(<3"x12")
Cyanogen bromide	(<3"x12")
Cyanogen chloride	(<3"x12")
Hydrogen bromide	
Hydrogen chloride	
Nitric oxide	(<3"x12")
Nitrogen dioxide	(<3"x12")
Nitrogen oxide	(<3"x12")
Nitrogen trioxide	(<3"x12")
Phosphorus pentafluoride	(<3"x12")
Silicon tetrafluoride	(<3"x12")
Sulfur dioxide	
Sulfur tetrafluoride	(<3"x12")

## DEFINITION OF HAZARDOUS WASTE

In addition to a number of "listed" solvents, acutely hazardous, and extremely hazardous substances, chemical wastes may be regulated as hazardous by the Environmental Protection Agency if they exhibit any of the following characteristics:

### **Ignitability**

A waste exhibits the characteristic of Ignitability if a representative sample of the waste has any of the following properties:

1. It is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume, and has flash point less than 60°C (140°F), as determined by a Pensky-Martens Closed Cup Tester or a Setaflash Closed Cup Tester, or as determined by an equivalent test method approved by the EPA.
2. It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture, or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard.
3. It is an ignitable compressed gas.
4. It is an oxidizer.

### **Corrosivity**

A waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties:

1. It is aqueous and has a pH less than or equal to 2, or greater than or equal to 12.5, as determined by a pH meter using either an EPA test method or an equivalent test method approved by the EPA.
2. It is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55°C (130°F), or in an equivalent test method approved by the EPA.

### **Reactivity**

A waste exhibits the characteristic of reactivity if a representative sample of the waste has any of the following properties:

1. It is normally unstable and readily undergoes violent change without detonating, e.g. explosive polymerization.
2. It reacts violently with water.

3. It forms potentially explosive mixtures with water.
4. When mixed with water, it generates toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.
5. It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.
6. It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.
7. It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.
8. It is a forbidden explosive, a Class A explosive, or a Class B explosive.

### **Toxicity**

A waste exhibits the characteristic of toxicity if a representative sample of the waste has any of the following properties:

1. Any chemical at the right dose could be toxic to humans. However, there are some chemicals that are known to be hazardous at very low concentrations, over a very short exposure time, or after repeated exposures. These chemicals are the toxins, poisons, and carcinogens.
2. A toxin may be mutagenic and cause a heritable change in the gene structure or may also be teratogenic and cause a malformation of an embryo. Pregnant women and persons in their childbearing years should not work with or, at a minimum, use extreme caution while handling these materials.
3. The toxicity of a material is due to its ability to interfere with the metabolism of living tissue. An acute toxin can cause an adverse effect after a single or short duration exposure. A chronic toxin causes an adverse effect after repeated exposures, after a long duration single exposure, or after a long latency period. Carcinogens are examples of chronic toxins that have a long latency period before the effects of the exposure are observed.
4. See Table 1 which follows for a list of toxic substances.

**TABLE I**  
**TOXICITY CHARACTERISTIC CONSTITUENTS**

CONSTITUENT	CAS NUMBER
Arsenic	7440-38-2
Barium	7440-39-3
Benzene	71-43-2
Cadmium	7440-43-9
Carbon tetrachloride	56-23-5
Chlordane	57-74-9
Chlorobenzene	108-90-7
Chloroform	67-66-3
Chromium	7440-47-3
o-Cresol	95-48-7
m-Cresol	108-3 9-4
p-Cresol	106-44-5
Cresol	
2, 4-D	94-75-7
1,4-Dichlorobenzene	106-46-7
1,2-Dichloroethane	107-06-02
1,1-Dichloroethylene	75-35-4
2,4-Dinitrotoluene	121-14-2
Endrin	72-20-8
Heptachlor (and its epoxide)	76-44-8
Hexachlorobenzene	118-74-1
Hexachlorobutadiene	87-68-3
Hexachlorethane	67-72-1
Lead	7439-92-1
Lindane	58-89-9
Mercury	7439-97-6
Methoxychlor	72-43-5
Methyl ethyl ketone	78-93-3
Nitrobenzene	98-95-3
Pentachlorophenol	87-86-5
Pyridine	110-86-1
Selenium	7782-49-2
Silver	7440-22-4
Tetrachloroethylene	127-18-4
Toxaphene	8001-35-2
Trichloroethylene	79-01-6
2,4,5-Trichlorophenol	95-95-4
2,4,6-Trichlorophenol	88-06-2
2,4,5-TP (Silvex)	93-72-1
Vinyl chloride	75-01-4

**Toxicity**

***A waste exhibits the characteristic of toxicity if the extract from a representative sample of the waste contains any of the contaminants listed in Table I at a concentration equal to or greater than the respective regulatory level. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering, is considered to be the extract for the purposes of this section.***

## List of Acutely Hazardous Waste

Acetaldehyde, chloro-	1-(o-Chlorophenyl)thiourea
Acetamide, N-(aminothioxomethyl)-	3-Chloropropionitrile
Acetamide, 2-fluoro-	Copper cyanide
Acetic acid, fluoro-, sodium salt	Copper cyanide Cu(CN)
1-Acetyl-2-thiourea	Cyanides (soluble cyanide salts), not otherwise specified
Acrolein	Cyanogen
Aldicarb	Cyanogen chloride
Aldrin	Cyanogen chloride (CN)Cl
Allyl alcohol	2-Cyclohexyl-4,6-dinitrophenol
Aluminum phosphide (R,T)	Dichloromethyl ether
5-(Aminomethyl)-3-isoxazolol	Dichlorophenylarsine
4-Aminopyridine	Dieldrin
Ammonium picrate (R)	Diethylarsine
Ammonium vanadate	Diethyl-p-nitrophenyl phosphate
Argentate(1-), bis(cyano-C)-potassium	O,O-Diethyl O-pyrazinyl phosphorothioate
Arsenic acid H <sub>3</sub> AsO <sub>4</sub>	Diisopropylfluorophosphate (DFP)
Arsenic oxide As <sub>2</sub> O <sub>3</sub>	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro- 1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4beta,5alpha,8alpha,8beta)-
Arsenic oxide As <sub>2</sub> O <sub>5</sub>	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro- 1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4beta,5beta,8beta,8beta)-
Arsenic pentoxide	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro- 1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2aalpha,3beta,6beta,6aalpha,7beta,7aalpha)-
Arsenic trioxide	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro- 1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2beta,3alpha,6alpha,6abeta,7beta,7aalpha)-, & metabolites
Arsine, diethyl-	Dimethonate
Arsonous dichloride, phenyl-	alpha, alpha-Dimethyl-phenethylamine
Aziridine	4,6-Dinitro-o-cresol, & salts
Aziridine, 2-methyl-	2,4-Dinitrophenol
Barium cyanide	Dinoseb
Benzenamine, 4-chloro-	Diphosphoramidate, octamethyl-
Benzamine, 4-nitro-	Diphosphoric acid, tetraethyl ester
Benzene, (chloromethyl)-	Disulfoton
1,2-Benzenediol, 4-[1-hydroxy-2- (methyl-amino)ethyl]-, (R)	Dithiobiuret
Benzeneethanamine, alpha, alpha- dimethyl-	Endosulfan
Benzenethiol	Endothall
2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenyl-butyl)-, & salts, when present at concentrations greater than 0.3%	Endrin
Benzyl chloride	
Beryllium	
Bromoacetone	
Brucine	
2-Butanone, 3,3-dimethyl-1-(methylthio)-, O- [(methylamino)carbonyl] oxime	
Calcium cyanide	
Calcium cyanide Ca(CN) <sub>2</sub>	
Carbon disulfide	
Carbonic dichloride	
Chloroacetaldehyde	
p-Chloroaniline	

Endrin, & metabolites  
 Epinephrine  
 Ethanedinitrile  
 Ethanimidothioic acid, N-[[[(methyl-amino) carbonyl]oxy]-, methyl ester  
 Ethyl cyanide  
 Ethyleneimine  
 Famphur  
 Fluorine  
 Fluoroacetamide  
 Fluoroacetic acid, sodium salt  
 Fulminic acid, mercury (2+) salt (R,T)  
 Heptachlor  
 Hexaethyl tetraphosphate  
 Hydrazinecarbothioamide  
 Hydrazine, methyl-  
 Hydrocyanic acid  
 Hydrogen cyanide  
 Hydrogen phosphide  
 Isodrin  
 3(2H)-Isoxazolone, 5-(aminomethyl)-  
 Mercury, (acetato-O)phenyl-  
 Mercury fulminate (R,T)  
 Methanamine, N-methyl-N-nitroso-  
 Methane, isocyanato-  
 Methane, oxybis[chloro-  
 Methane, tetranitro- (R)  
 Methanethiol, trichloro-  
 6,9-Methano-2,4,3-benzodioxathiepin,  
 6,7,8,9,10, 10-hexachloro-1,5,5a,6,9,9a-  
 hexahydro-, 3-oxide  
 4,7-Methano-1H-indene, 1,4,5,6,7,8,8-  
 heptachloro- 3a,4,7,7a-tetrahydro-  
 Methomyl  
 Methyl hydrazine  
 Methyl isocyanate  
 2-Methylactonitrile  
 Methyl parathion  
 alpha-Naphthylthiourea  
 Nickel carbonyl  
 Nickel carbonyl Ni(CO)<sub>4</sub>, (T-4)-  
 Nickel cyanide  
 Nickel cyanide Ni(CN)<sub>2</sub>  
 Nicotine, & salts  
 Nitric oxide  
 p-Nitroaniline  
 Nitrogen dioxide  
 Nitrogen oxide NO  
 Nitrogen oxide NO<sub>2</sub>  
 Nitroglycerine (R)  
 N-Nitrosodimethylamine

N-Nitrosomethylvinylamine  
 Octamethylpyrophosphoramidate  
 Osmium oxide OsO<sub>4</sub>, (T-4)-  
 Osmium tetroxide  
 7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid  
 Parathion  
 Phenol, 2-cyclohexyl-4,6-dinitro-  
 Phenol, 2,4-dinitro-  
 Phenol, 2-methyl-4,6-dinitro-, & salts  
 Phenol, 2-(1-methylpropyl)-4,6-dinitro-  
 Phenol, 2,4,6-trinitro-, ammonium salt (R)  
 Phenylmercury acetate  
 Phenylthiourea  
 Phorate  
 Phosgene  
 Phosphine  
 Phosphoric acid, diethyl 4-nitrophenyl ester  
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 Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester  
 Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl]ester  
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 Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester  
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 Phosphorothioic acid, O,O-dimethyl O-(4-nitrophenyl) ester  
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 Potassium cyanide K(CN)  
 Potassium silver cyanide  
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 Propanenitrile  
 Propanenitrile, 3-chloro-  
 Propanenitrile, 2-hydroxy-2-methyl-  
 1,2,3-Propanetriol, trinitrate (R)  
 2-Propanone, 1-bromo-  
 Propargyl alcohol  
 2-Propenal  
 2-Propen-1-ol  
 1,2-Propylenimine  
 2-Propyn-1-ol

4-Pyridinamine  
Pyridine, 3-(1-methyl-2-pyrrolidinyl)-,(S)-, & salts  
Selenious acid, dithallium(1+) salt  
Silver cyanide  
Silver cyanide Ag(CN)  
Sodium azidide  
Sodium cyanide  
Sodium cyanide Na(CN)  
Strychnidin-10-one, & salt  
Strychnidin-10-one, 2,3-dimethoxy-  
Strychnine, & salts  
Sulfuric acid, dithallium(1+) salt  
Tetraethyldithiopyrophosphate  
Tetraethyl lead  
Tetraethyl pyrophosphate  
Tetranitromethane (R)  
Tetraphosphoric acid, hexaethyl ester  
Thallic oxide  
Thallium oxide  $Tl_2O_3$   
Thallium (I) selenite  
Thallium (I) sulfate  
Thiodiphosphoric acid, tetraethyl ester  
Thiofanox  
Thiomidodicarbonic diamide  $[(H_2N)C(S)]_2NH$   
Thiophenol  
Thiosemicarbazide  
Thiourea, (2-chlorophenyl)-  
Thiourea, 1-naphthalemyl-  
Thiourea, phenyl-  
Toxaphene  
Trichloromethanethiol  
Vanic acid, ammonium salt  
Vanadium oxide  $V_2O_5$   
Vanadium pentoxide  
Vinylamine, N-methyl-N-nitroso-  
Warfarin, & salts, when present at concentrations greater than 0.3%  
Zinc cyanide  
Zinc cyanide  $Zn(CN)_2$   
Zinc phosphide  $Zn_3P_2$ , when present at concentrations greater than 10% (R,T)

Selenourea



**REQUEST FOR DISPOSAL -  
BIOLOGICAL WASTE AND SHARPS**

The University of Texas at Arlington  
Environmental Health & Safety  
Hazardous Materials Section

500 Summit Avenue  
Box 19257  
Phone : 272-2185 FAX: 272-2144

Location of Pickup: Department: \_\_\_\_\_ Building: \_\_\_\_\_ Room: \_\_\_\_\_

Person Generating the waste, or the representative who will aid in the disposal:

Name: \_\_\_\_\_ Phone: \_\_\_\_\_ Box No.: \_\_\_\_\_  
(Must be UTA employee)

**General Instructions:** Only the materials listed will be picked up. See the back of this form for important information. Mail, deliver, or FAX this form to the address above.

1. **Microbiological Waste:** Must be autoclaved or chemically disinfected and disposed of in accordance with the rules described on the back of this form. If this is not possible, contact EH&S for assistance.
2. **Bedding of Animals Exposed to Pathogens:** Must be disposed of in the incinerator at the Life Sciences Building. If you have any questions, contact EH&S for assistance.
3. **Animal Carcasses and Body Parts:** Must be double-bagged to prevent leakage and kept frozen until incinerated.
4. **Blood, Blood Products, and Human Tissues:** May not be discharged into sanitary sewer system. Must be placed in biohazard containers and picked up by EH&S
5. **Needles, Razors, Scalpels, Pasteur Pipettes and Infectious Glass:** Must be placed into the sharps containers provided and picked up by EH&S.
6. **If you have any other type of biological waste not mentioned above,** and you have questions regarding the appropriate treatment and disposal method, contact the EH&S Hazardous Materials Section at 272-2185 for assistance.
7. **This form is not to be used for radioactive waste.** If you have questions concerning the disposal of radioactive waste, contact the EH&S Radiation Safety Section at 272-2185

Description of Material to be disposed of: \_\_\_\_\_

If **Sharps** (#5 above), indicate number and size of containers: \_\_\_\_\_

**Pathogenic or carcinogenic agent:** (Identify) \_\_\_\_\_

**NOTE SPECIAL PRECAUTIONS FOR DISPOSAL PERSONNEL:** \_\_\_\_\_

**OFFICE USE ONLY**

Method of final disposal \_\_\_\_\_ Weight \_\_\_\_\_

Date \_\_\_\_\_ By \_\_\_\_\_

Rev. 2/1/97

## ADDITIONAL INSTRUCTIONS

### Microbiological Waste

Microbiological waste includes:

1. cultures and stocks of infectious agents and associated biologicals
2. cultures of specimens from medical, pathological, pharmaceutical, research, clinical, commercial, and industrial laboratories
3. discarded live and attenuated vaccines
4. disposable culture dishes (including those containing unused media)
5. disposable devices used to transfer, inoculate, and mix cultures

### Acceptable methods of treatment of microbiological waste:

#### Steam sterilization

1. temperature of at least 121°C
2. pressure of at least 15 psi
3. time of at least 30 minutes

#### Chemical Disinfection

1. Use a chemical agent which is registered with the EPA as a disinfectant and in accordance with the manufacturer's instructions, **or**
2. immerse the waste for not less than 3 minutes in:
  - a. a freshly prepared solution of household bleach diluted 1:10 with water or
  - b. a solution of 70% by volume of 2-propanol (isopropyl alcohol)  
(Waste which has been immersed in a liquid disinfectant must be thoroughly drained before disposal.)

### Disposal of treated microbiological waste

Microbiological waste which has been treated in accordance with the methods described above can be disposed of through the regular trash as long as the following steps are taken:

1. Place a label on the bag or container stating "treated in accordance with 1.136 of the TAC SWFHCRF" (available from EH&S, Hazardous Materials Section, and
2. Place the labeled bag into another sealed bag or container that is a different color and is opaque, e.g., a black trash bag.

### Bedding of Animals Exposed to Pathogens

Must be disposed of in the incinerator at the Life Science Building

### Record Keeping

#### Microbiological Wastes

A lab which generates **50 pounds or less** per calendar month of these wastes must record the following:

1. date of treatment
2. amount of waste treated
3. method/conditions of treatment
4. name (printed) and initials of person(s) performing treatment

A lab which generates **more than 50 pounds** per calendar month of these wastes must record the following:

1. all of the above with the addition of a written procedure for the operation and testing of any equipment used and a written procedure for the preparation of any chemicals used in treatment.

#### Incinerator

Record in the Incinerator Log Book the following information on material to be incinerated:

- Date and time
- Weight and type material
- If material is radioactive, you must record approximate activity
- Print name and initial entry

Incinerator Log Books are located in the Biology and Psychology Offices.

# REQUEST FOR DISPOSAL OF HAZARDOUS CHEMICALS

The University of Texas at Arlington  
 Environmental Health & Safety  
 Hazardous Materials Section  
 500 Summit Avenue  
 Box 19257  
 Fax: 272-2144  
**Phone: 272-2185**

Facility (check one)  
 Main Campus      ARRI

**OFFICE USE ONLY**

Date Received \_\_\_\_\_  
 Date Due \_\_\_\_\_  
 Date Picked up \_\_\_\_\_

**Requested by:** Name: JOHN DOE Department: CHEMISTRY Box: 12345 Phone: 6789  
{Must be UTA Employee}

**Alternate Contact:** Name: NA Phone: NA **Location of Pickup:** Building: CRB Room#: 400

	Tag #	Contents <small>Use full chemical or product name(s) - List All components</small>	% of Content	Total Amount of Contents	Physical State S or L
Container	7451	LITHIUM ALUMINUM HYDRIDE	100	25g	S
			100%		
Container	7452	HEXANE ACETONE METHANOL ETHYL	50 10 25 15	4 L 1 L 2 L 1 L	
			100%		
Container	7452	SALICYLIC ACIS ACETANILIDE SULFURIC ACID ACETONE SODIUM HYDROXIDE	< 1 <1 1 5 94	4 g 1 g 100 ml 300 ml 6 L	S S L L L
			100%		

The materials listed are accurately described above and are packaged and labeled according to the procedures of EH&S Laboratory Safety Manual.

Signature: JOHN DOE Date: 1/31/2007  
{Must be UTA employee, e.g. faculty, staff, TA or RA}

\*Form **not** to be used for **Radioactive Waste**. If you have questions concerning the disposal of radioactive waste, contact the Radiation Safety Section, 272-2185.

# REQUEST FOR DISPOSAL OF HAZARDOUS CHEMICALS

The University of Texas at Arlington  
 Environmental Health & Safety  
 Hazardous Materials Section  
 500 Summit Avenue  
 Box 19257  
 Fax: 272-2144  
**Phone: 272-2185**

Facility (check one)  
 Main Campus      ARRI

**OFFICE USE ONLY**

Date Received \_\_\_\_\_  
 Date Due \_\_\_\_\_  
 Date Picked up \_\_\_\_\_

**Requested by:** Name: \_\_\_\_\_ Department: \_\_\_\_\_ Box: \_\_\_\_\_ Phone: \_\_\_\_\_  
{Must be UTA Employee}

**Alternate Contact:** Name: \_\_\_\_\_ Phone: \_\_\_\_\_ **Location of Pickup:** Building: \_\_\_\_\_ Room#: \_\_\_\_\_

	Tag #	Contents Use full chemical or product name(s) - List <u>All</u> components	% of Container	Total Amount of Contents	Physical State S or L
Container					
Container					
Container					

The materials listed are accurately described above and are packaged and labeled according to the procedures of EH&S Laboratory Safety Manual.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_  
{Must be UTA employee, e.g. faculty, staff, TA or RA}

\*Form **not** to be used for **Radioactive Waste**. If you have questions concerning the disposal of radioactive waste, contact the Radiation Safety Section, 272-2185.



N<sup>o</sup> A 7451  
Container No.

3-10-07  
Date

**HAZARDOUS CHEMICAL INVENTORY TAG**  
(Please Print)

Principal Investigator John Doe

Phone: Ext. 1234

Bldg Science Hall Rm No. 500

INDICATE OVERALL VOLUME OR WEIGHT:

**LIQUID:**      ml / L **SOLID:** 25 g g / KG

**SPECIFY CHEMICAL CONTENTS**

SHOW VOLUME OR WEIGHT AND

PERCENTAGE FOR EACH CHEMICAL

(Use full chemical name or chemical formula.

Do not use abbreviations or structural formula.)

Substance	AMOUNT. (g, KG, ml, L)	%
Lithium Aluminum Hydride	25g	100

Total 100%

(USE REVERSE SIDE OF TAG TO LIST ADDITIONAL CHEMICALS)

**All containers must have proper caps. Leaking containers or unknowns will NOT be picked up.**

SECURE TAG TO CONTAINER (NO TAPE)

N<sup>o</sup> A 7452  
Container No.

3-10-07  
Date

**HAZARDOUS CHEMICAL INVENTORY TAG**  
(Please Print)

Principal Investigator John Doe

Phone: Ext. 1234

Bldg Science Hall Rm No. 500

INDICATE OVERALL VOLUME OR WEIGHT:

**LIQUID:** 8L ml / L **SOLID:**      g / KG

**SPECIFY CHEMICAL CONTENTS**

SHOW VOLUME OR WEIGHT AND

PERCENTAGE FOR EACH CHEMICAL

(Use full chemical name or chemical formula.

Do not use abbreviations or structural formula.)

Substance	AMOUNT. (g, KG, ml, L)	%
Hexane	4L	50
Acetone	1L	12.5
Methanol	2L	25
Ether	1L	12.5
Total		100%

(USE REVERSE SIDE OF TAG TO LIST ADDITIONAL CHEMICALS)

**All containers must have proper caps. Leaking containers or unknowns will NOT be picked up.**

SECURE TAG TO CONTAINER (NO TAPE)

N<sup>o</sup> A 7453  
Container No.

3-10-07  
Date

**HAZARDOUS CHEMICAL INVENTORY TAG**  
(Please Print)

Principal Investigator John Doe

Phone: Ext. 1234

Bldg Science Hall Rm No. 500

INDICATE OVERALL VOLUME OR WEIGHT:

**LIQUID:** 6.4L ml / L **SOLID:**      g / KG

**SPECIFY CHEMICAL CONTENTS**

SHOW VOLUME OR WEIGHT AND

PERCENTAGE FOR EACH CHEMICAL

(Use full chemical name or chemical formula.

Do not use abbreviations or structural formula.)

Substance	AMOUNT. (g, KG, ml, L)	%
Salicylic Acid	40g	-----
Acetanilide	12g	-----
Sulfuric Acid	100ml	1
Acetone	300ml	5
Sodium Hydroxide	6L	94
Total		100%

(USE REVERSE SIDE OF TAG TO LIST ADDITIONAL CHEMICALS)

**All containers must have proper caps. Leaking containers or unknowns will NOT be picked up.**

SECURE TAG TO CONTAINER (NO TAPE)

**The University of Texas at Arlington  
Environmental Health & Safety (EH&S)  
272-2185**

**Safety Evaluation**

Date:		EH&S Personnel:	
Department:		Building:	
Principal Investigator:		Room:	
Contact:		Phone:	

S = Satisfactory      N = Needs Improvement      N/A = Not Applicable  
Prerequisites need to be met to ensure regulatory compliance.

Hazard Communication Act/ General Safety	S	N	N/A	Comments/Notes
1. All lab personnel have completed Hazard Communication training.				
2. Site specific training is documented and available for review.				
3. The UT Arlington Laboratory Safety Manual is available and easily accessible.				
4. A chemical inventory list is maintained and current.				
5. MSDS are available or readily accessible for every hazardous chemical present and lab personnel know where and how to obtain MSDS.				
6. The labels on incoming chemical containers are not removed or defaced.				
7. Secondary containers, other than ones for immediate use, are labeled with the identity of their contents.				
8. All chemicals are stored by hazard class, flammables, oxidizers, acids, bases, reactives, and toxins.				
9. No breakable chemical containers are stored on the floor.				
10. All chemical containers are kept closed if not in use.				
11. No hazardous chemicals are stored above eye level.				
12. Flammables stored in the lab are minimized and are kept in flammable storage cabinets.				
13. Chemicals are dated when received and not stored beyond their expiration date.				
14. Refrigerator/freezers labeled either "Food & Drinks Only" or "No Food & Drinks".				
15. Flammable liquids are not stored in household refrigerators.				
16. Lab Personnel do not eat, drink or apply cosmetics in lab.				
17. Compressed gas cylinders are secured and the safety cap is in place when cylinders are not in use.				
18. Spill control materials are available in the lab.				

Chemical Waste	S	N	N/A	Comments/Notes
1. Chemical waste is located in the immediate vicinity of generation and under supervision of the person who generated it.				
2. All containers are clearly labeled with the contents of the container and the words "Hazardous Waste".				
3. All containers are closed unless actively receiving waste.				
4. Waste container is properly stored in secondary containment.				
5. No containers are leaking.				
6. No waste is poured down the drain.				
7. All containers are compatible with their contents.				
8. Less than a total of one quart of acutely hazardous waste is present.				
9. Less than a total of 55 gallons of possibly hazardous waste is present. If no: Has a Request for Disposal (RFD) been sent?				
10. If the container contains a reactive, a cancer suspect, or infectious agent, is this noted on the container?				
11. Any labels which are incorrect should be defaced.				
12. Each waste container has a properly filled out waste tag attached to it.				
13. For containers that are ready for disposal: Has EH&S been contacted for pick-up (RFD submitted)?				
14. Chemical waste compliance poster is posted in the lab where hazardous waste is accumulated.				

Special Waste	S	N	N/A	Comments/Notes
1. All sharps are deposited into red sharps containers provided and picked up by EH&S.				

2. There is no evidence of bent, re-capped, or clipped needles.			
3. Sharp containers are not more than ¾ full.			

Personal Protective Equipment	S	N	N/A	Comments/Notes
1. The appropriate personal protective clothing for work being performed is present, in good condition and used by lab personnel.				
2. Occupants do not wear open-toed shoes, sandals, flip-flops, clogs, etc.				

Engineering Controls	S	N	N/A	Comments/Notes
1. Fume hoods are working properly and only essential items are stored in them.				
2. Fume hoods have been tested by EH&S within the past year.				
3. The fume hood is being used at a proper sash height.				
4. Biological safety cabinets are used properly and are certified on an annual basis or after being moved or repaired.				
5. Emergency showers are available and unobstructed.				
6. Emergency showers have been tested by EH&S within the past year.				
7. Eyewashes are available and unobstructed.				
8. Eyewash has been tested by EH&S within the past year.				

Fire/Life Safety	S	N	N/A	Comments/Notes
1. All exits and walkways in the lab are free of obstructions and tripping hazards.				
2. Lab doors are kept closed as much as possible to provide a fire and smoke barrier.				
3. If more than 10 gallons of flammables are being used in the laboratory, are they stored in fire rated storage cabinets?				
4. The storage of combustibles, e.g., cardboard boxes and paper is kept to a minimum and is not stored within 24" of the ceiling in non-sprinkled buildings or within 18" of the sprinkled head in a sprinkled building.				
5. The fire extinguisher is unobstructed and has been inspected within the past year.				
6. The ceiling is intact (i.e., ceiling tiles in place, etc.)				
7. Bunsen burner tubing is checked regularly and any cracked or brittle tubing is replaced.				

Electrical Safety	S	N	N/A	Comments/Notes
1. All electrical cords are in good condition. None have exposed wiring, cracked, brittle, or frayed insulation.				
2. No electrical/extension cords are run above the ceiling tiles.				
3. The use of extension cords in the lab is minimized.				
4. No electrical cords are run across the floor where they could be a tripping hazard.				
5. There is clear access to the breaker panel.				

Physical Hazards	S	N	N/A	Comments/Notes
1. All belt driven vacuum pumps are protected with belt guards, properly maintained and stored away from flammable chemicals and combustible material.				
2. Glassware used at pressures other than ambient are taped or shielded				
3. Broken glassware is deposited into puncture resistant containers which are provided by and picked up by Custodial Services.				

Inspector Signature: \_\_\_\_\_ Date: \_\_\_ / \_\_\_ / \_\_\_

Reviewer Signature: \_\_\_\_\_ Date: \_\_\_ / \_\_\_ / \_\_\_



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