LABORATORY SAFETY MANUAL
(Chemical Hygiene Plan)

THE UNIVERSITY OF TEXAS AT ARLINGTON
ENVIRONMENTAL HEALTH AND SAFETY
OCTOBER 2011
FOREWORD

The Environmental Health & Safety Office (EH&S) supports the University in its quest to excel in research, teaching, and service. 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 reagents, 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 of Texas at Arlington does not currently fall under the jurisdiction of the Occupational Safety and Health Administration (OSHA), we provide information concerning the Bloodborne Pathogens Standard. Please contact our Hazardous Materials section at 817-272-2185 for more information.
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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.

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; and
3) To train individuals and inspect work areas where hazardous materials are stored and used.

C. KEY RESPONSIBILITIES

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

<table>
<thead>
<tr>
<th>Responsible Party</th>
<th>Required Action</th>
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<tbody>
<tr>
<td>Lab Personnel</td>
<td>Complete Hazardous Communication/RCRA (waste management) training.</td>
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<td>Meet labeling requirements of the Hazard Communication Act.</td>
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<td>Perform self-audit (See Evaluation Form in APPENDIX X) of the lab for health and safety conditions no less than once every</td>
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<tr>
<td><strong>Lab Personnel</strong></td>
<td>Contact EH&amp;S if fume hoods, safety showers, or eyewash are not working properly.</td>
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<tr>
<td></td>
<td>Do not allow hazardous waste to accumulate. Send EH&amp;S a properly-completed request for disposal.</td>
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<tr>
<td><strong>Faculty</strong></td>
<td>Ensure that lab personnel properly dispose of or transfer all hazardous materials before leaving the University.</td>
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<td><strong>EH&amp;S</strong></td>
<td>Provide Hazardous Communication/RCRA training and Site-Specific training annually.</td>
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<td>Pick up hazardous waste as needed after receiving request for disposal,</td>
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<td>Inspect 100% of all labs annually.</td>
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<td>Inspect labs using infectious agents in accordance with the CDC/NIH Guidelines.</td>
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<td>Inspect all labs where controlled substances or precursor chemicals are used.</td>
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<td>Test all fume hoods, safety showers, and eyewashes semi-annually.</td>
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<td>Participate as a member of the UT Arlington Chemical/Biological Safety Committee and perform inspections as required.</td>
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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:

- 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;
- Inspect all fume hoods, safety showers, and eyewashes semi-annually;
- Inspect all areas generating regulated waste for compliance with applicable regulations at least once each calendar year;
- Inspect 100% of all laboratories and other associated areas using hazardous materials (biological and chemical) for safe laboratory practices each year;
- Inspect all laboratories known to EH&S to be purchasing controlled substances or precursor chemicals for proper controls once each calendar year;
- Remove all regulated wastes from the site of generation within three working days from the date of receiving a properly-completed Request for Disposal;
- 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 her or his own safety and for the safety of others. Before starting any work in the lab, become familiar with the procedures, equipment, and reagents used in the lab. If you do not understand something, ask! The following guidelines are recommended for working safely in a lab.

1) Personal Practices
• Never wear loose clothing, shorts, sandals, flip-flops, clogs, or open-toed shoes in the lab. Do not wear synthetic fabrics, such as polyester, that burn easily. This is not a dress code. Rather it is intended to protect you from exposure to hazardous materials by minimizing the amount of exposed skin and lessening the degree of flammability.

• Wear lab coat or apron, gloves, and eye and face protection at all times.

• Do not wear excessive jewelry that might get caught in equipment, trap reagents against your skin, or react with chemicals.

• Do not wear contact lenses in a lab because chemicals or particulates can get caught behind them and severely damage your eyes.

• Confine long hair.

• Do not allow children or pets in laboratories.

• Never pipette anything by mouth.

• Designate non-lab areas for eating, drinking, and applying cosmetics. Remember, smoking is not allowed in any University building.

• Store food and drinks in refrigerators that are designated for that use only. These should not be located within the laboratory.

• 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.

• Wash your hands frequently throughout the day and before leaving the lab.

• 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. This is also for your personal safety.

2) Housekeeping

• Clean your work areas throughout the day and before you leave.
• If necessary, clean equipment after use to avoid the possibility of contaminating the next person who needs to use it.

• Keep all aisles and walkways in the lab clear to provide a safe walking surface

B. Recommended Lab Techniques

This section deals with techniques, equipment, and procedures commonly found within a laboratory. It is beyond the scope of this manual to describe all techniques and equipment that may be used in a particular lab. Your faculty member/principal investigator is responsible for site-specific training on these issues. For further information on this topic, see reference 1.

1) Glassware

• Inspect all glassware before use. Discard any broken, cracked, or chipped glassware in a broken glassware box. These are available in the Chemistry Stockroom.

• Use vacuum-resistant reinforced plastic ware whenever possible. If you must use glass, tape or shield glass vacuum vessels to prevent flying glass in the case of an implosion.

• Do not use household Thermos bottles as substitutes for laboratory Dewar flasks; the walls are too thin.

• Always use secondary containment. Transport all glass chemical containers in rubber or polyethylene bottle carriers. Utilize a cart or make more than one trip if necessary.

• Fire-polish all cut glass tubing and rods before use.

• Practice the following when inserting glass tubes or rods into stoppers:
  • The diameter of the tube must be compatible with the diameter of the stopper.
  • Fire-polish the end of the glass tube.
  • Lubricate the glass with water or glycerol.
  • Wear heavy gloves and hold the glass not more than two inches from the end
to be inserted.

- Insert the glass carefully with a twisting motion.
- Remove stuck tubes by slitting the stopper with a sharp knife.

2) Assembling Apparatus

- Keep work surfaces as uncluttered as possible.
- Only use equipment that is free from cracks, chips, and other defects. For example, vacuum pumps must have belt guards.
- Set up a clean, dry apparatus, firmly clamped and back away from the edge of the lab bench.
- If possible, place a pan under a reaction vessel or other container to contain liquid if the glassware breaks.
- Do not allow burners or any other ignition sources nearby when working with flammable liquids.
- Lubricate glass stopcocks. Do not lubricate Teflon® stopcocks.
- 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 or the floor.
- Position an apparatus attached to a ring stand with the center of gravity over the base and not to one side.
- Assemble apparatus so that burners or baths can be removed quickly.
- Use an appropriate vapor trap and confine the setup to a fume hood if there is a possibility of producing hazardous vapors.
- Put the setup in a fume hood when conducting a reaction that could result in an implosion or explosion. Raise the sash no more than 18 inches above the counter. If it is not possible to use a fume hood, use a standing shield that is stabilized and secured.
Always wear a lab coat and proper eye and face protection. Personal protective equipment (PPE) is described in detail in Sections 6 and 7.

3) Centrifuges

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

4) Ultraviolet Lamps

- Wear ultraviolet-absorbing protective safety glasses while working with ultraviolet light. Your ordinary eyeglasses and sunglasses are not designed to protect you from these intense UV rays.
- Wear a lab coat or long sleeves to protect your skin from potential burns.
- Shield any experiment in which ultraviolet light is used in order to prevent escape of the direct beam or scattered radiation.

5) Separatory Funnels

- Use extreme caution if the temperature of the materials is elevated.
- When you use a volatile solvent, swirl the unstopped separatory funnel first to allow some solvent to vaporize and to release pressure.
- Close the funnel and invert it with the stopper held in place, then immediately open the stopcock to release pressure.
- 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 fume hood.

- Close the stopcock, swirl the funnel, then immediately open the stopcock with the funnel in an inverted position to vent the vapor again.

6) Cooling Baths and Cold Traps

- Always use caution when working with cryogenic coolants. Refer to the cryogenic materials section of this manual for additional details.

- Use temperature-resistant gloves and a face shield while slowly immersing an object to be cooled.

- Do not pour cold liquid onto the edge of a glass Dewar flask when filling because the flask may break and implode.

- Never lower your head into a Dry Ice chest; no oxygen is present.

- Wear temperature-resistant gloves while handling Dry Ice. If you use no protection, you can be severely burned.

7) Vacuum Pumps

- If at all possible, vent vacuum pump exhaust into a fume hood.

- Guard all belt-driven vacuum pumps to prevent hands or loose clothing from getting caught in the belt pulley.

- Place a trap between the vacuum pump and the apparatus.

- Lubricate the pump regularly if possible. Check belt conditions and do not operate in a fume hood cabinet that is used for storage of flammables.

8) 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 fume hoods. If the traps are allowed to dry out, odors present in the sanitary sewer system will vent into the lab.

9) Electrical
• Examine all electrical cords periodically for signs of wear and damage. If you discover damaged electrical cords, unplug the equipment and send it off for repair.

• Properly ground all equipment.

• If you notice sparks while plugging or unplugging equipment or if the cord feels hot, do not use the equipment until an electrician can service it.

• Do not run electrical cords along the floor where they will be a tripping hazard and be subject to wear. If you must run a cord along the floor temporarily, protect it with a cord cover.

• Do not run electrical cords above the ceiling. The cord must be visible at all times to ensure it is in good condition.

• Do not plug too many items into a single outlet. Do not use cords that enable you to plug more than one item in at a time. You may use multi-plug strips if they are protected with a circuit breaker as long as you do not use them in series. In addition, do not use them for major pieces of equipment; plug these directly into a wall socket.

• 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.

Reference


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 the magnitude of all possible occurrences that can create or complicate an emergency, such as the following.

• What are potential spill locations? Can you consolidate any materials or move them to safer areas?

• What materials might be spilled? Are any incompatible with each other?
• What quantities may be involved in a spill? Are more materials being stored in the lab than you actually need?

• What are the materials’ hazardous properties?

• What personal safety equipment might you need? Is it available? Are personnel trained to use it properly? Is appropriate equipment available for all possible needs?

• You should assemble supplies and equipment and keep them 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. You can obtain chemical spill control kits from EH&S Hazardous Materials section at 817-272-2185.

• Post a list of telephone numbers near every entrance of each laboratory, storeroom, and on every telephone. Outside every exterior door, post the telephone numbers of the principal investigator (PI), UT Arlington Police Department (817-272-3003), and EH&S (817-272-2185.) Callers should explain the situation clearly, calmly, and in detail.

• Since each laboratory is unique in its use of hazardous materials and physical surroundings, use the emergency procedures listed below but adapt them to your particular needs. The best plan becomes useless if specific basic safety equipment and supplies are not readily available when needed. Do not keep equipment for unlikely contingencies in labs because you can call emergency responders in these cases. Train personnel on whom to call if they do occur. Make trial runs once procedures and equipment become available.

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

Several Problems Can Complicate an Emergency:

• Failure of personnel to respond promptly to the emergency.

• Failure of personnel to recognize the need to summon additional help.

• Inadequately trained personnel taking the wrong actions in response to an emergency.
• Personnel lacking information pertinent to the nature of the emergency that would substantially change the proper response to the emergency.

• Personnel endangering themselves while attempting to rescue others.

A. PRIMARY EMERGENCY PROCEDURES FOR GENERAL SPILLS

1) Spill Equipment

• Supplies for cleaning up a minor chemical or biological spill should be readily available.

• Supplies for a chemical spill include an inert absorbent such as kitty litter or vermiculite, a plastic (non-sparking) scoop, plastic bags to contain the material, chemical-resistant gloves, goggles, sodium bicarbonate to neutralize acids, and citric acid to neutralize bases.

• Supplies for a biological spill also include paper towels and a fresh 1:10 bleach solution.

2) Procedure

• 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 UT Arlington Police Department at 817-272-3003 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. Emergency assistance will respond to your request.

• 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 chemical vapor or a fire (even if not started yet).

• If the spilled material is flammable, turn off all potential ignition sources.

• Notify EH&S (817-272-2185).

• 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.
• Leave on or establish exhaust ventilation if it is safe to do so. Close doors to slow down the spread of odors.

• Use a spill control kit appropriate for material spilled.

• During cleanup, wear appropriate protective apparel.

• 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, neutralize corrosives prior to absorption. Clean spills from the outer areas first, then move towards the center.

• Place the spilled material into an impervious container, seal, and contact EH&S for disposal.

• Wash the affected surface with soap and water. Mop up the residues and containerize for disposal.

• A solvent such as ethanol may be necessary to clean surfaces contaminated with a water-insoluble 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.

• Do not forget to notify your PI.

B. SPECIAL PROCEDURES FOR RADIOACTIVE HAZARD SPILLS

Also refer to the UT Arlington Radiation Safety manual.

• 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 UT Arlington Police Department at 817-272-3003 for assistance with injuries, fires, or rescues. Give the nature and the extent of the emergency; be as specific and detailed as possible. Emergency assistance will respond upon your request.

• Remove all personnel from immediate spill area to a safe meeting location in or near the lab. Your lab should already have a designated meeting place.

• Shut off ventilation, close windows and doors, turn off hoods if possible.
• Notify EH&S (817-272-2185). Obtain appropriate radiation meters if available. Be sure to notify your PI.

• Under the direction of the EH&S Radiation Safety section, check all personnel for skin and clothing contamination.

• 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 BIOHAZARD SPILLS

If there is an emergency or if anyone is in danger, immediately call the UT Arlington Police Department, 817-272-3003, for assistance. Give the nature and the extent of the emergency being as specific and detailed as possible. Emergency personnel will be dispatched to help you.

If, however, there is no immediate threat to health, you should use your best judgment to decide whether to call for help or to address the matter yourself. The guidelines below are intended to help you decide.

Prioritize your actions to deal with the spill:

• Call UT Arlington police dispatch at 817-272-3003 for help if there is an emergency.
• Notify EH&S, 817-272-2185, and your PI.

• Determine exactly what has been spilled. Mostly you will only need to deal with one type of dangerous material at a time.

Biohazardous materials must first enter the body through a specific exposure route. Once in the body the host's immune response determines whether infection will occur. Knowing the identity of the infectious agent and the route of exposure is essential in being able to clean up spilled biohazardous materials safely.

However, if the spilled material contains a mixture of chemical, biological, and radioactive materials, consider the threats separately and address them in the following order.

• Chemical hazards. Many chemicals can cause immediate injury and you should address these first.
• Biological hazards. Address these second.

• Radioactive hazards. Radioactive materials can spread very easily, and can be difficult to clean up. Time of exposure and distance from the material are key factors in determining a dose; the shorter the exposure time and the further away from it you are, the smaller the dose. Address these as soon as possible. Refer to the UTA Radiation Safety Manual.

Take the appropriate steps to deal with the spill. Each PI should be responsible for developing spill clean-up procedures that are appropriate for the materials used in the laboratory. Having a carefully planned biological hazards spill kit stored in a suitable place and updated regularly will make accident cleanup easier and also give a peace of mind in the laboratory. Anyone working with biohazardous materials must receive training in spill cleanup appropriate for materials routinely used. (Look below for items suggested for a biological hazards spill kit.)

You should follow the following procedures to deal with a spill of biohazardous materials, either outside or inside a biological safety cabinet.

Biohazard Spills Outside a Biological Safety Cabinet

• Holding your breath, leave the room immediately and close the door(s).

• Notify persons in the immediate area about the spill. Warn others not to enter the contaminated area.

• In a different location, remove contaminated clothing and place it in a biohazard bag or properly-labeled container for autoclaving.

• In a different location, if you suspect that your shoes have been contaminated, remove them and place in a separate biohazard bag for decontamination.

• In a different location, thoroughly wash your hands, face, and any other exposed areas of the body. If the spilled material has soaked through laboratory clothing, take a complete body shower. Use safety showers and eyewashes as appropriate.

• If the spill involves potential exposure to bloodborne pathogens, follow UT Arlington’s bloodborne pathogen policy (Exposure Control Plan for Bloodborne Pathogens) for managing and reporting these exposures.
• Wait at least 30 minutes to allow aerosols to settle before entering the contaminated area.

• Put on protective clothing and equipment (lab coat/gown, gloves, masks, eye protection, and face shield) after assembling the needed cleanup materials and before re-entering the room. If your gloves are not puncture-resistant, be especially careful if the spill involves broken glass or other sharps.

• Apply appropriate disinfectant for the agent involved in the spill with a gentle flooding action to avoid secondary aerosols.

• Cover excess liquids with absorbent material, such as paper towels soaked with the decontaminant.

• Allow an adequate contact time for disinfectant to work.

• Use disinfectant solution to wipe over surrounding areas that are likely to have been contaminated with aerosols and splashes.

• Decontaminate boots, discard the gloves and masks/shields and either discard or decontaminate clothing (lab coat/gown) used during the cleanup.

• Place all contaminated spill cleanup materials (paper towels, glass, liquid, gloves, etc.) into an autoclavable bag/container and autoclave it according to standard directions, or call EH&S for disposal.

• Wash your hands thoroughly.

Spills outside the Laboratory (During Transport)

If a biohazardous agent spills during transport outside the laboratory, the main difference from the first procedure is to initiate the cleanup immediately. You can follow the procedures stated above for Biohazard Spills outside a Biological Safety Cabinet.

Biohazard Spills Inside a Biological Safety Cabinet

In order to prevent escape of contaminants from the cabinet while the cabinet continues to operate, initiate decontamination procedures at once.

• Spray or wipe walls, work surfaces, and equipment within the cabinet with a solution of an appropriate decontaminant for the agent involved. If your gloves
are not puncture-resistant, be especially careful if the spill involves broken glass or other sharps. You can also use mechanical means such as tongs, forceps, or small disposable scoops.

- Flood the top work surface tray and, if it is a Class II biological safety cabinet, the drain pans and catch basins below the work surface with the decontaminant and allow to stand for 10-15 minutes. Extend the contact time to 30 minutes for large spills or spills containing large amounts of proteinaceous materials.

- Remove excess decontaminant from the tray by wiping with a sponge or cloth soaked in decontaminant. For Class II biological safety cabinets, drain the tray into the catch basin below the work surface. Lift out the tray and removable front intake grille and wipe off top and bottom (underside) surfaces with a sponge or cloth soaked in a decontaminant.

- Replace the grille and drain decontaminant from the cabinet base into an appropriate container and autoclave according to standard procedures. Be sure to place gloves, cloths, and/or sponges into an autoclavable container to be autoclaved.

- If the spill in the cabinet is quite substantial, it may be necessary to decontaminate the cabinet’s fans, filters, and airflow plenums. An outside company must do this. Call EH&S (817-272-2185) for assistance.

- Notify your PI.

**Biohazard Spills in a Centrifuge**

When a spill or leak has occurred within a centrifuge, the procedure for cleanup depends upon the risk group of the sample involved as well as the construction of the equipment.

Centrifuges with sealed rotors or buckets that are able to be autoclaved should be steam-sterilized intact at 121°C for an appropriate time.

For centrifuges with non-sealed rotors and centrifuges not able to be autoclaved, allow 30 minutes for aerosols to settle first. Place the rotor or bucket in an appropriate non-corrosive disinfectant solution. Keep in mind that bleach will corrode stainless steel if left in contact with it for 30 minutes or more. After disinfection, remove larger pieces of broken glass/sharps using forceps and place in a biohazards sharps container. Carefully wipe the internal surfaces of the centrifuge bowl with disinfectant.
Biological Hazards Spill Kit

A well-designed biological hazards spill kit is highly recommended. The following items would be excellent choices for a kit:

- “DO NOT ENTER” sign to be posted on the laboratory door.

- An appropriate chemical decontaminant(s). In most cases 10% household bleach solution is a good choice, but keep in mind that bleach will corrode stainless steel if left in contact with it for 30 minutes or more. Whenever you use bleach to clean up spills of an infectious agent, prepare a fresh solution. After about one week, a bleach and water solution will lose its effectiveness for decontamination.

- For human blood and body fluids, iodophors or 70% alcohol is appropriate.

- Materials to absorb liquids after decontamination. This could include paper towels, absorbent lab pads, or special materials designed to absorb large volumes of liquid. Keep in mind the volumes of liquid typically used in the laboratory area when selecting an absorbent.

- Appropriate personal protective equipment to wear during cleanup. Gloves and a long-sleeved laboratory coat or gown are always necessary. Consider facial protection for large spills.

- A mechanical means for handling broken glass. Broken glass represents a high cutting danger. Do not touch it directly, especially if it is contaminated with a biohazardous agent. Mechanical means could include tongs, forceps, small disposable scoops and sponges, autoclavable dustpans, or any other method that prevents direct contact with the broken glass.

- Biohazard bags, sharps containers, and/or other containers to place the material in for further treatment and disposal.

D. BUILDING EVACUATION PROCEDURES

- Building evacuation may be necessary if there is a chemical release, fire, explosion, natural disaster, or medical emergency.

- Be aware of the marked exits from your area and always know two ways out of the building. The way you came in may not be the best way out.
The evacuation alarm is a recorded evacuation message. The fire alarm is also a notice to evacuate without a recorded message.

To activate the building fire alarm system, pull the handle on one of the red boxes located by an exterior exit. If there is a fire, call UT Arlington police at 817-272-3003, from a campus phone outside the alarm building or from a cell phone or call 911, give your name, and describe the location and size of the fire.

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.

Once outside, proceed to a clear area that is at least 150 feet from the affected building. Keep walkways clear for emergency vehicles. Your lab should already have a designated meeting place.

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.

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.

Do not return to the building until campus police or EH&S tell you it is safe to do so.

E. EMERGENCY EQUIPMENT

Know the location of your emergency shower, eyewash, and fire extinguisher! In the event of an emergency, you do not want to waste time searching for them. 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.

1) Safety Showers

To ensure a clean supply of water in the safety shower, flush it weekly for 5 minutes to remove any rust or sediment that may have accumulated. Catch
the water in a bucket and discard down the sink.

- Use an emergency shower to decontaminate a person who has been exposed to hazardous chemicals and to suppress a fire.

- Remove all clothing, jewelry, and shoes while standing under the shower. If you do not remove these items, they will hold the chemicals against your skin and increase the damage. Use a fire blanket as a modesty curtain for the person disrobing. Everyone can leave the lab while you shower.

- Remain under the shower for at least 15 minutes, and then seek medical attention.

- Always keep the area under an emergency shower (and eyewash) unobstructed. You do not want to waste time moving boxes, trash, tables, or other items. Electrical equipment in the area can present an electrocution hazard.

- 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 slippery!

### 2) Eyewashes

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 your eyelids open.

- To ensure a clean supply of water in the eyewash, operate the eyewash weekly to flush any rust or sediment that may have accumulated.

- Never hesitate to flush your eyes immediately if chemicals are splashed in them. Even a delay of a few seconds could cause permanent damage.

- You should not be wearing contact lenses, but if you are, remove them immediately. Materials could be trapped under the contacts on the surface of your eyes.

- If chemicals are splashed into your eyes, hold the eyelids open and flush with water continuously for at least 15 minutes.
- Move the eye up and down and sideways to wash thoroughly behind the eyeball where chemicals could be trapped.

- Seek medical attention.

- Notify your PI.

**Note:** EH&S inspects and tests emergency showers and eyewash fountains semi-annually. If these items are not operating properly, contact EH&S at 817-272-2185.

3) **Fire Extinguishers**

- Labs will be equipped with an ABC dry chemical powder fire extinguisher. Use the ABC extinguisher on a paper, chemical, or electrical fire. *Never use a water fire extinguisher on an electrical fire.*

- Only use a Class D combustible metal fire extinguisher on a metal (magnesium, sodium, potassium, etc.) fire. There are also commercially-available materials that can be applied to a burning metal fire. Class D extinguishers are yellow in color and located in the corridors outside the labs in buildings with combustible metals.

- Attempt to extinguish small fires yourself only if you have been trained and can safely do so. Always fight the fire from a position that allows an escape route behind you. Always activate the building fire alarm before attempting to extinguish a fire.

- To use a fire extinguisher, follow these four steps. The mnemonic is **PASS**:
  a. **Pull** the pin.
  b. **Aim** the extinguisher nozzle at the base of the fire.
  c. **Squeeze** the handle to release the extinguishing agent.
  d. **Sweep** 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.

- If you cannot extinguish the fire in approximately 30 seconds, evacuate the area, closing the door as you leave.

- If a fire extinguisher is used, is vandalized, or for any other reason is in need of service, call the EH&S Fire section at 817-272-2185 for immediate
replacement.

- For training in 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 817-272-2185.

- Notify your PI of any lab fires.

5. Hazard Communication Act

The 69th Legislature of the State of Texas in 1985 enacted the Texas Hazard Communication Act (1). The law became effective January 1, 1986, and was most recently revised in 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. UTA also has a Hazard Communication Manual for additional guidance.

A. REQUIREMENTS

1) Training

New employees must complete the online Hazardous Communication/Resource Conservation and Recovery Act (RCRA) (2) 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.

- Employees must be retrained when new chemical hazards are introduced in their workplace or when new information is shown on updated Material Safety Data Sheets (MSDS).

- Employees must be retrained when they are assigned to different workplaces that involve new chemical hazards.

In addition to the Hazardous Communication/RCRA training, all employees must complete Site-Specific training for their individual workplaces. Site-Specific training must cover the unique hazards (chemical, biological, radiological) with which the employee works.

2) Labels
Every hazardous chemical container must have a label that identifies it and lists the appropriate hazard warnings. For new reagents, this is the original manufacturer’s label on the original bottle. Do not deface or remove this label.

When you transfer a reagent to a secondary container, label the container with at least the name of the reagent appearing on the MSDS and the pertinent physical and health hazards, including the organs that would be affected, 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 reagent.

3) Material Safety Data Sheets (MSDS)

MSDS provide information on a specific reagent 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.)

4) Posters

Employee notification posters (UT Arlington Hazardous Waste Satellite Accumulation Area posters) must be displayed in the workplace and should be covered in training. These posters must be kept current.

Employee Notification posters must also be posted whenever chemical hazards are present. These posters are available through EH&S.

B. MATERIAL SAFETY DATA SHEETS (MSDS)

Because MSDS are so important, they will be discussed in further detail. MSDS are a critical component of the United States Occupational Safety and Health Administration's (OSHA) Hazard Communication Standard (3). This standard mandates that workers have a right to know what hazards are associated with the chemicals they use in the workplace. Both manufacturers of chemicals and employers with chemicals in their workplace must comply with this regulation.

EH&S maintains a master file (electronic copies) and can provide MSDS to University personnel who need them. OSHA’s Hazard Communication Standard (HCS) specifies certain information that must be included on MSDS, but does not require that any particular format be followed in presenting this information (3).

The OSHA MSDS format has the following required categories that must be on every MSDS:
Section I. Manufacturer's name and contact Information
Section II. Hazardous ingredients/identity Information
Section III. Physical/Chemical characteristics
Section IV. Fire and explosion hazard data
Section V. Reactivity data
Section VI. Health hazard data
Section VII. Precautions for safe handling and use
Section VIII. Control measures

In order to promote consistent presentation of information, OSHA recommends that MSDS follow the 16-section format established by the American National Standards Institute (ANSI) (4).

The 16 sections of an MSDS that are prescribed by the ANSI standard are as follows:

Section 1 - Chemical product and company information

- The name, address, and phone number of the company that makes the chemical
- The chemical name and any synonyms
- The Chemical Abstracts Service (CAS) number

Section 2 – Composition and information on ingredients

The product's individual hazardous chemicals and their relative percentages are listed. Many products contain mixtures of chemicals. All ingredients that meet OSHA Hazard Communication standard criteria of a hazardous chemical must be identified here.

The manufacturer has several options as to how the ingredients may be listed. The active ingredients regulated under federal, state, or local regulations must be listed. The nonhazardous ingredients may or may not be included. Some complex mixtures recognized as a single substance may be listed as a single component.

"Trade secrets" are protected and may be listed as such instead of identifying each component. Suppliers of these "trade secret" substances must still provide health hazard data on the MSDS and additional information to safety professionals who have a documentable need to know.

This section should include the material's exposure limits if they are known. Several organizations recognized by OSHA have developed exposure limits for a variety of hazardous substances. It is worth noting that the combination of exposures to more
than one hazardous chemical is far greater than exposure to individual hazardous chemicals.

Exposure to certain hazardous materials may be acceptable, but only for periods of time not to exceed certain time limits and at concentration no greater than certain levels. This section lists these values so the employee handling the hazardous materials knows what precautions (protective equipment, ventilation, etc.) should be taken so as not to exceed these exposure limits. The employee can refer to later sections in the MSDS that describe measures that can help reduce possible exposure.

Section 3 - Hazards Identification

This section includes routes of entry, target organs, potential short-term (acute) health effects, long-term (chronic) health effects, and medical conditions that may be exacerbated by exposure. Potential acute health effects include the symptoms of short-term exposure. Potential chronic health effects includes carcinogenic (cancer-causing) effects, mutagenic (mutation inducing) effects, teratogenic (birth defect-causing) effects, and developmental (prenatal or postnatal to the time of sexual maturity) toxicity.

Section 4 - First Aid Measures

If accidental exposure were to occur, then this section is valuable to determine the immediate first aid response. This section should indicate the proper first aid treatment for accidental exposure by inhalation, skin, eye, and ingestion. Almost in every MSDS the first statement says, "Call a Physician." In most cases, skin and eye exposure are standard, i.e., "immediately flush eyes or skin with plenty of water for at least 15 minutes." Inhalation is also usually standard too, "remove to fresh air, if not breathing, give artificial respiration, if breathing is difficult, give oxygen."

The first aid response to ingestion does vary. One would believe that inducing vomiting would be the standard response. However, in many cases, this would result in greater respiratory damage than the damage by ingestion. An antidote may often be listed which can be administered by a layperson or a trained medical personnel.

Section 5 - Fire and Explosion Data

This section of the MSDS describes the basic fire-fighting measures. This should include the fire and explosive properties of the material and the proper extinguishing materials. The precautions and safety procedures to put out a fire effectively are described here. This is important because knowing the flammable properties along with the chemical and physical properties provide a good indication of how dangerous the material is in a fire situation. Important flammable properties listed here should include:
• **Flash point** -- the lowest temperature at which a flammable liquid gives off enough vapor to form an ignitable mixture with air. In other words, the lowest temperature at which a liquid can ignite if a spark is present. Liquids with very low flash points are dangerous fire hazards.

• **Auto ignition temperature** -- the temperature at which the liquid will set itself on fire without a flame or spark.

• **Lower explosive limit (LEL)** -- the minimum concentration of a flammable gas or vapor (% by volume in air) in which an explosion can occur if a flame or spark is present.

• **Upper explosive limit (UEL)** -- the maximum concentration of a flammable gas or vapor (% by volume in air) in which an explosion can occur if a flame or spark is present.

• **Hazardous products of combustion** -- In most fires, the greatest danger to human life is not the heat of the flames, but the toxic smoke that can fill the area. All the anticipated products of combustion are listed here. Laboratory fires are far more dangerous than common fires because the toxic fumes are often far more dangerous.

All MSDS describe the fire extinguishing media in this section. Selecting the appropriate fire extinguisher is critical in an emergency situation.

**Section 6 - Accidental Release Measures**

When a hazardous material is accidentally spilled, the emergency can be minimized if proper response is immediate. Therefore, reviewing this section before using a chemical will prepare you in the event of a hazardous spill. This section describes evacuation procedures, containment and cleanup techniques, and other emergency advice like personal protective equipment and respirators.

Information from this section will allow you to plan for emergency responses, training of individuals using the hazardous material, and making available in the laboratory necessary equipment to quickly contain and clean up a spill or leak.

If the spill is small, the advice in this section can be very useful. However, if the spill is large, evacuate the area and call the UTA Police dispatch at 817-272-3003 and EH&S at 817-272-2185. Make sure that the doors of the affected area are closed and people
Section 7 - Handling and Storage

General handling precautions and practices are described to prevent release into the environment and overexposure during contact with the material. In addition, this information will help you minimize continued contact after handling. For example, wash hands with soap and water after handling, especially before eating.

The storage of chemical reagents varies depending on the chemical's reactivity and flammability. The necessary storage conditions to avoid damage to containers, contact with incompatible materials and resulting dangerous reactions, evaporation, decomposition, and flammable and explosive atmospheres in the storage area are detailed in this section. For example, protect against sunlight, refrigerate, keep container tightly closed, and store separate from oxidizing materials.

Section 8 - Exposure Controls/Personal Protection

The intent of this section is to reduce exposure of the laboratory worker to the hazardous chemical. Exposure controls include engineering controls like fume hoods, ventilation, and glove boxes. Exposure controls also includes administration controls such as training, labeling and warning devices.

This section provides the important information about personal protective equipment (PPE). Some of the PPE are respirators, safety goggles, gloves, aprons, and boots. The PPE recommendations include both normal use and emergency response during a fire, spill, leak, or accidental release. The description of the PPE often includes details about what materials the PPE should be made of or the best type of respirator for vapor of the hazardous chemical.

Sometimes exposure limits like the OSHA PELs are listed here rather than in section 2. This information is important because there are many types of PPE available and the employer should have available the PPE that will provide the best protection for their employees.

To maintain a safe exposure level, the engineering controls are extremely important. If a laboratory has poor ventilation, then the exposure limits can be exceeded if the chemical is used repeatedly throughout the day. If the fume hood is cluttered with
unnecessary items, the hood will not pull the vapors away properly. Do not store reagents or equipment in the fume hoods.

Section 9 - Physical/Chemical Characteristics

The information in this section may appear very scientific, but it is actually very basic. It tells you what conditions will change the chemical’s form, thereby affecting the type and degree of the chemical’s hazard, for example, boiling point, melting point, vapor pressure, vapor density, evaporation rate, solubility in water, and specific gravity.

Section 10 - Stability and Reactivity Data

This section contains information about what could happen if the chemical is mixed with air, water, or other chemicals. It explains what conditions and chemicals to avoid.

Section 11 - Toxicological Information

Information concerning the hazardous chemical's toxicity is listed in this section. However, this information can be listed in other sections of the MSDS like the Health Hazard and First Aid section. This information reflects animal testing, and if known, human data if accidental human poisoning occurred and the amounts of exposure are known. This toxicity data are mainly intended for medical professionals, occupational health and safety professionals, and toxicologists.

The data may include acute, subchronic and chronic exposures through various routes:

- inhalation (inhal)
- ingestion (oral)
- intraperitoneal (ipr)
- subcutaneous (scu).

LD50, the dose that kills 50% of lab animals, is expressed in milligrams per kilogram and is used to represent oral, ipr, and scu exposures. LC50 is the concentration in air of a substance that kills 50% of lab animals and is used to express inhalation exposures. In addition, LDLo (LDL) and LCLo are sometimes listed and these values depict the lowest dose or concentration known to have cause death in a lab animal. The lab animals can include rats, mice, rabbit, and guinea pigs.

Section 12 - Ecological Information

Not all MSDS have this section. If it does, this helps the environmental professional or hazmat personnel in evaluating the effect a chemical may have if it is released into the
environment. The person using the chemical may use this information to determine waste treatment practices.

Ecotoxicity data may have information on acute and chronic toxicity to fish, invertebrates, plants, microorganisms, and toxicity to animals drinking water contaminated with the chemical. Chemical behavior in air, soil, and water may include persistence and degradation, soil mobility, bioaccumulation, and photolytic stability. All of this is important in evaluating the environmental impact of a chemical in the event of major spill or determining whether a chemical can be safely disposed of in a landfill.

Section 13-Disposal Considerations

The person responsible for waste management activities on campus will certainly find this section important so the University can stay within the law when removing the chemical from the premises. However, the lab worker using the reagent should also be aware of disposal aspects of the chemical so he/she does not inadvertently dispose of the waste improperly.

This section usually contains information on special disposal methods and waste management’s options like recycling. Also included are limitations directed by federal, state, or local governments.

**Note:** These are methods recommended by the chemical manufacturer and are not necessarily in compliance with federal, state, or local regulations. RCRA training becomes important for waste disposal procedures, please refer to the Chemical Waste section of this manual, or contact the EH&S Hazardous Material Section at 817-272-2185.

Section 14-Transport Information

The shipping of hazardous materials is regulated by the Department of Transportation (DOT). This section provides the important DOT shipping name, ID (UN or NA numbers), hazard class, and labels required to be on the container.

Section 15 - Other Regulatory Information

This section provides the regulatory information for regulatory compliance personnel. These regulations are specified by OSHA, Toxic Substances Control Act (TSCA) (5), Superfund Amendments and Reauthorization Act (SARA) (6), and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (7). Reportable quantities for spills, storage, and shipping may also be listed. Finally, international regulations, federal, state and local regulations should be found in this section.
Section 16 - Other Information

This section is intended to be used for any addition important information not listed in other sections. This can include references, keys/legends, creation and revision dates, and hazardous ratings such as the National Fire Protection Association (NFPA) codes. The information here can complete the process of providing all necessary information to the person reading the MSDS. Many MSDS include a disclaimer in this section as well.

**IMPORTANT:** If you have any questions about how to read a MSDS or about information contained in a MSDS, ask your immediate supervisor or call EH&S at 817-272-2185.

**MSDS Terms and Acronyms**

*Action level, AL* -- Certain OSHA regulations take effect if this exposure level (concentration in air) is reached. These regulations include workplace air analysis, employee training, medical monitoring, and record keeping. This level is about half of the permissible exposure limit.

*Ceiling, C* -- This is the employee's exposure, which shall not be exceeded at any time during the workday.

*Immediately dangerous to life and health, IDLH* -- These values are used to determine the appropriate respirators for hazardous chemicals. These values stand for the maximum concentration from which a worker could escape within 30 minutes without any escape-impairing symptoms or irreversible health effects in the event of a respirator failure.

*Lethal concentration 50, LC-50* -- This concentration of a hazardous material in air is expected to kill 50% of a group of test animals when given as a single respiratory exposure in a specific time period.

*Lethal concentration low, LC-LO* -- This value indicates the lowest concentration of a substance in air that caused death in humans or laboratory animals. The value may represent periods of exposure that are less than 24 hours (acute) or greater than 24 hours (subacute and chronic).

*Lethal dose 50, LD-50* -- The single dose, other than inhalation, that causes death in 50% of an animal population from exposure to a hazardous substance.

*Lethal dose low, LD-LO or LDL* -- The lowest dose, other than inhalation, that caused death in humans or animals.
Milligrams per cubic meter of air, mg/m³ -- This is the unit for measuring concentrations of particulate (minute dust-like particles) in air.

Parts per million, ppm -- This is a common unit of concentration of gas or vapor in air expressed with many exposure limits. It is defined as parts of gas or vapor per million parts of air by volume at 25°C and 1 atm pressure.

Permissible exposure limit, PEL -- This is one of the most important OSHA limits used. It is defined as the allowable limit for air contaminant in which workers may be exposed day after day without adverse health effects.

Recommended Exposure Limit, REL -- This is the highest allowable air concentration that will not injure a person.

Short-term exposure limit, STEL -- This is the 15-minute time-weighted average exposure which must not be exceeded at any time during a workday.

Threshold limit value, TLV -- This is the air concentration level of hazardous substances to which workers may be repeatedly exposed day after day without adverse health effects.

Threshold limit value time-weighted average, TLV-TWA -- This is the time-weighted average concentration for an 8-hour workday and a 40-hour work week in which a worker may be repeatedly exposed without adverse health effects.

Threshold limit value short-term exposure limit, TLV-STEL -- This is the maximum concentration to which workers can be exposed for 15 minutes continuously without adverse health effects. Only four of these 15-minutes exposures are permitted per day and 60 minutes must pass between exposures. The TLV-TWA still must not be exceeded.

Threshold limit value ceiling -- This is a defined boundary, unlike TLV, which are guidelines. It is the concentration, which should never be exceeded at any time during the working exposure.

Time-weighted average -- This is the worker’s average airborne exposure in any 8-hour workday of a 40-hour work week, which should not be exceeded.

Note: A sample MSDS is included in APPENDIX I.

References
   http://www.dshs.state.tx.us/tiertwo/pdf/NoticeEng.PDF and 

2. United States Resource Conservation and Recovery Act (RCRA) 

3. United States Occupational Health and Safety Administration. 29 CFR 
   1910.1200(g) 

   Standard for Hazardous Industrial Chemicals Material Safety Data Sheets 
   Preparation. 
   http://oncampus.richmond.edu/academics/labsafety/chemicals/The%20ANSI%20Standardized%20MSDS%20Format.pdf and 

   http://www.epa.gov/lawsregs/laws/tsca.html


6. Chemical Hazards and Control

Note: If you are pregnant or considering becoming pregnant, EH&S strongly advises you to discuss this with your research advisor. You may enroll in general chemistry, but you should seriously consider not enrolling in any course above general chemistry (organic, for example).

A. CHEMICAL CATEGORIES, 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 and use chemicals safely.

General Storage Guidelines (1, 2)

*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, such as a peroxide former, 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.

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, for example, flammables, toxins, reactives, and oxidizers. Within these groups, chemicals can be stored in alphabetical order to locate them. If a chemical exhibits more than one hazard, use the highest hazard(s) on the NFPA label to segregate it.

Do not store chemicals near heat sources such as ovens or steam pipes. Also, do not store chemicals in direct sunlight.

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. Each chemical should have a designated storage location and should be put there after use.

Inspect your chemicals routinely for any signs of deterioration and for the integrity of the label. To comply with the Texas Hazard Communication Act, *all* chemicals must be clearly labeled. Labeling also prevents unknown chemicals from shipping as chemical waste until an expensive analysis has been performed to identify them. Everything should be done to prevent chemicals from becoming unknowns.

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.

Do not use fume hoods 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 fume hood, the greater the likelihood of having chemical vapors being drawn back into the room. Some chemical fume hoods have ventilated storage cabinets underneath, and this is a good place to put chemicals that require ventilation.
Promptly contact EH&S for the disposal of any old, outdated, or unused chemicals.

Seal chemicals that require refrigeration with tight-fitting caps and store them in a refrigerator labeled for this purpose.

Do not store chemicals above eye level. Eye level is usually the height of an average person. If the container breaks, the contents can fall onto your face and upper body, which are generally unprotected areas.

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, for example, 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 you must decide 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**

**General Characteristics**

Flammable liquids are the most common 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.

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.

The flash point of a chemical is the 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; for example, the flashpoint of diethyl ether is –45.0°C, acetone has a flashpoint of –17.8°C, and
isopropanol 11.7°C.

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 concentration in air 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.

Most flammable vapors have a vapor density greater than that of air. The result is that these vapors will seek the lowest elevations, in other words, they sink. 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 greater distance from where the flammables are used.

Use and Storage

Store flammable liquids in safety cans, storage cabinets designed for flammables, or inside storage rooms specifically designed for flammables.

Minimize the amount of flammable liquids stored in the lab.

Use flammables only in an area free of ignition sources. Remember, smoking is not permitted inside any University building.

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 grounded before pouring. Large containers such as drums must also be grounded when used as a dispensing or receiving vessel. All grounding connections must be metal-to-metal. Safety catalogs carry the necessary grounding wires.

Never heat flammables by using an open flame. Use steam baths, water baths, oil baths, sand baths, heating mantles, or hot air baths.

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.

1) *Acute Health Effects*

- Inhalation commonly causes headache, fatigue, dizziness, drowsiness, and narcosis (stupor and unresponsiveness.)
- Ingestion causes slight gastrointestinal irritation, dizziness, and fatigue.
- Skin contact causes dry, cracked, and chapped skin.
- Eye contact causes stinging, watering eyes, and inflammation of the eyelids.

2) *Chronic Health Effects*

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.

- 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.
- The vapors of alcohols are only moderately narcotic.
- Ethers exhibit strong narcotic properties and are only moderately toxic.
- The vapors of esters may result in irritation to the eyes, nose, and upper respiratory tract.
- The systemic toxicity of ketones is generally not high.
First Aid

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

For ingestion, remove the person from the source of contamination. Get medical attention. Do not induce vomiting.

For skin contact, remove the person from the 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 for excessive exposure.

For eye contact, remove the 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 fume hood while working with flammable liquids. Nitrile and neoprene gloves are effective against most flammables. Wear a non-flammable lab coat such as Nomex to provide a barrier to your skin. Always wear safety glasses.

OXIDIZERS

General Characteristics

Oxidizers or oxidizing agent’s 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, causing the spontaneous ignition of combustibles with which it comes in contact, or undergo an explosive reaction when exposed to heat, shock, or friction. Oxidizers are generally corrosive.

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. An 85% perchloric acid solution is a strong oxidizer at room temperature.

Do not order or use anhydrous perchloric acid, HClO₄. 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.

Examples of common oxidizers include peroxides, nitrates, nitrites, perchlorates, chlorates, chlorites, hypochlorites, dichromates, permanganates, and persulfates.

**Use and Storage**

In general, store oxidizers away from flammables, organic compounds, and combustible materials.

Store strong oxidizing agents like chromic acid in glass or some other inert container, preferably unbreakable. Do not use corks or rubber stoppers.

Do not heat reaction vessels containing appreciable amounts of oxidizing material in oil baths, but rather on a heating mantle or sand bath.

*Use and Storage of Perchloric Acid, HClO₄*

Perchloric acid deserves special mention within the category of oxidizing materials. As mentioned above, a heated solution of perchloric acid is a very strong oxidizing agent.

*Do not* attempt to heat perchloric acid if you do not have access to a properly functioning perchloric acid fume hood. Perchloric acid can only be heated in a hood especially 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.

- Whenever possible, substitute a less hazardous reagent for perchloric acid.

- Perchloric acid should be stored in a perchloric acid fume hood. 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. Store the bottle of perchloric acid in a glass secondary container to contain any leakage.

- 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 because of their potential to add to the
severity of a fire or to initiate a fire. But some generalizations can be made regarding the health hazards of an oxidizing material. In general, oxidizers are corrosive and many are highly toxic.

1) **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.

2) **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 directly contacted oxidizing materials, the person must be removed from the source of contamination as quickly as possible if it is safe to do so. Summon medical help. In the case of an exposure directly to the skin or eyes it is imperative that you take the exposed person 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. Also consult the glove manufacturer for additional information.

You must wear chemical splash goggles if the potential for splashing exists or if exposure to vapor or gas is likely.

Always use oxidizing materials in a chemical fume hood as most do pose a hazard via inhalation. Cylinders of compressed gases should be kept in ventilated cabinets.
CORROSIVES

General Characteristics

Corrosives are most commonly acids and alkalis, but many other materials can also be severely damaging to living tissue. 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.

Certain substances considered noncorrosive in their natural dry state are corrosive when wet, such as when in contact with moist skin or mucus membranes. Examples of these materials are lithium chloride, halogen fluorides, and allyl iodide.

Sulfuric acid (H$_2$SO$_4$) 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.

Examples of corrosives include sulfuric acid, ammonium bifluoride, chromic acid, bromine, stannic chloride, sodium hydroxide, and ammonium hydroxide.

Use and Storage

Always store acids separately from bases. Also, store acids away from flammables, since many acids are also strong oxidizers.

Do not work with corrosives unless an emergency shower and continuous flow eyewash are available.

*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.

Never store corrosives above eye level. Store them on a low shelf or cabinet.

It is a good practice to store corrosives in secondary containment to contain any leakage.

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.

Store corrosives in a wooden cabinet or one that has a corrosion-resistant lining. Corrosives stored in a metal cabinet will quickly damage the cabinet. If the supports that hold up the shelves become corroded, the result could be disastrous.
Do not store hydroxides in glass containers. Hydroxides slowly react with glass to produce silicates. Instead, use plastic containers.

1) Use and Storage of Hydrofluoric Acid, HF

Hydrofluoric acid is extremely hazardous and deserves special mention. Hydrofluoric acid can cause severe burns and inhalation of anhydrous hydrogen fluoride gas 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. Only persons fully trained in the hazards of hydrofluoric acid should use it. Always double-glove and wear a lab coat.

*Do not use hydrofluoric acid without having a tube of calcium gluconate nearby.* Calcium gluconate bonds to free fluoride ions before they can penetrate the skin.

Always use hydrofluoric acid in a properly functioning fume hood. Ideally a fume hood or section of a fume hood should be dedicated to hydrofluoric acid use.

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, apply calcium gluconate liberally, then seek prompt medical attention. If you suspect that you have inhaled hydrogen fluoride vapors, move immediately to an uncontaminated atmosphere if it is safe to do so, keep warm, and seek prompt medical attention. Death from inhalation or skin contact can occur!

Never store hydrofluoric acid in a glass container because it is incompatible with glass. Store it in its original container. If you must remove some to dilute it, use a plastic vial.

Store hydrofluoric acid separately from other acids 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 metals.

Skin contact with alkali metal hydroxides such as 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 halide acids 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.

1) Acute Health Effects

Inhalation results in irritation of mucus membranes, difficulty in breathing, fits of coughing, and pulmonary edema.

Ingestion results in irritation and burning sensation of lips, mouth, and throat, pain in swallowing, swelling of the throat, painful abdominal cramps, vomiting, shock, and risk of perforation of the stomach.

Skin contact with acids results in burning, redness and swelling, painful blisters, and profound damage to tissues. Skin contact with alkalis causes a slippery, soapy feeling.

Eye contact causes stinging, watering of eyes, swelling of eyelids, intense pain, ulceration of eyes, and loss of eyes or eyesight.

2) Chronic Health Effects

Symptoms associated with 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 are decreased bone density, fluorosis, and anemia; the chronic effects of sodium hydroxide are unknown.

First Aid

For inhalation, remove the person from the source of contamination if it is safe to do so. Get medical attention. Keep person warm and quiet and do not leave unattended.

For ingestion, remove the person from the source of contamination. Get medical attention and inform emergency responders of the name of the chemical swallowed. Do not induce vomiting.

For skin contact, remove the person from the source of contamination and take
immediately to an emergency shower or source of water. Remove clothing, shoes, socks, and jewelry from affected areas, cutting them off if necessary, as quickly as possible. Be careful not to get any corrosive on your skin or inhale the vapors. Flush the affected area with water for a minimum of 15 minutes. Get medical attention.

For eye contact, remove the person from the 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 her/his eyes up and down and from side to side while flushing with water. Get medical attention. Do not let person rub her/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. Wear a rubber-coated apron and goggles. If splashing is likely to occur, wear a face shield over the goggles. Always use corrosives in a chemical fume hood.

**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 polyvinyl benzene.

*Water-Reactive Materials*

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. Water-reactive materials can be particularly hazardous to fire-fighting personnel because water is the most commonly used fire-extinguishing medium.

Examples of water-reactive materials include alkali metals, silanes, alkyl aluminum, magnesium, zinc, and aluminum.
Pyrophoric Materials (3)

**Note:** see the separate handout on pyrophoric materials on the EH&S web site.

Pyrophoric materials can ignite spontaneously in the presence of air at less than 45°C (130°F). They react with water in the air, oxygen, or both.

Examples of pyrophoric materials include diethyl zinc, triethyl aluminum, and many other organometallic compounds.

Peroxide-Forming Materials (4)

**Note:** see the separate handout on peroxide-forming materials on the EH&S web site.

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 trinitrotoluene (TNT). Just the friction from unscrewing the cap of a container of an ether containing peroxides can provide enough heat to cause a severe explosion.

The table below lists some examples of peroxide-forming materials.

<table>
<thead>
<tr>
<th>Most Hazardous</th>
<th>Less Hazardous</th>
</tr>
</thead>
<tbody>
<tr>
<td>acrylonitrile</td>
<td>styrene</td>
</tr>
<tr>
<td>sodium amide</td>
<td>divinylacetylene</td>
</tr>
<tr>
<td>dioxane</td>
<td>potassium amide</td>
</tr>
<tr>
<td>tetrahydrofuran</td>
<td>diethyl ether</td>
</tr>
<tr>
<td>butadiene</td>
<td>vinyl ethers</td>
</tr>
<tr>
<td>isopropyl ether</td>
<td>vinylpyridine</td>
</tr>
</tbody>
</table>

Other Shock-Sensitive Materials

chemicals containing nitro groups
fulminates
hydrogen peroxide (30% +)
ammonium perchlorate
benzyol peroxide (when dry)
picric acid (when dry)
anhydrous perchloric acid
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**

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.

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 in a clearly-marked cabinet, or preferably in a glove box or other controlled atmosphere. Do not store pyrophorics near flammables and ignition sources. 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**

Do not open the reagent 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, liquid stratification, or unusual viscosity before opening. Look for signs of precipitation, stratification of liquid, crystal formation, or other irregularities. The presence of any of these signs indicates the potential for a shock sensitive container. *Do not move the container and contact EH&S as soon as possible.* 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.

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. Many chemical companies now routinely print an expiration date on containers of the worst peroxide formers.

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.

Secure the lids and caps on these containers to discourage the evaporation and concentration of these chemicals.

Store peroxide formers in sealed, air-impermeable containers such as dark amber glass with a tight-fitting cap. Metals inhibit the formation of peroxides in some materials, which is why diethyl ether and some other materials are sold in metal cans. Ground glass-stoppered bottles and plastic containers are not advisable; avoid friction and grinding. However, plastic squeeze bottles may be used for small quantities of some materials, such as 2-propanol, for immediate use.

Inhibitors are added to some chemicals, and whenever possible purchase peroxide formers with added inhibitors. However, be aware that these free-radical inhibitors will be depleted over time as peroxides are formed. Additionally, distillation removes the inhibitor. Distilled peroxide formers and those retained for extended periods should be checked for inhibitor concentration and inhibitor added if below the manufacturer’s recommended concentration.

A chemical test can be performed to check for the presence of peroxides in liquids. However, if you suspect that peroxides may be present, it is probably wise to call EH&S for disposal.

Never distill any peroxide-former, especially alcohols and ethers, 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.

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 because of inhalation of fumes, vapors, and reaction products. A very serious hazard is flying debris which can inflict physical injuries.

First Aid

If someone is seriously injured, your most important step is to contact emergency responders as quickly as possible. This is best accomplished by directly calling the UT Arlington Police Department, 817-272-3003. 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 and keep the person calm until help arrives.

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 their feet about one foot above the floor or above their heart.

Personal Protective Equipment

Wear appropriate personal protective clothing while working with highly reactive materials. This might include impact-resistant chemical splash goggles, a face shield, gloves, a lab coat (to minimize injuries from flying glass or an explosive flash), and a shield. Conduct work within a chemical fume hood 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 fume hood, 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

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 toxins, poisons, and carcinogens.

A toxin may be mutagenic (causes a heritable change in the gene structure) or may also be teratogenic (causes a malformation of an embryo or fetus.) Pregnant women and persons in their childbearing years should not work with or, at a minimum, use extreme caution while handling these materials.

The toxicity of a material is 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.

Examples of acute toxins include hydrogen cyanide, diisopropyl fluorophosphate, hydrogen sulfide, hydrofluoric acid, nitrogen dioxide, and phosgene.

Examples of chronic toxins include all carcinogens and many metals and their compounds.

Use and Storage

Minimize your exposure to chemicals that are known to be highly toxic 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 fume hoods or biological safety cabinets as appropriate.

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.

Thoroughly wash your hands and arms before leaving the work area and at the end of
the day.

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.

Use absorbent paper on the work surface to contain spills.

Restrict access where toxic materials are used and post signs if special toxicity hazards exist.

Vacuum pumps that are used with materials having high chronic toxicity should be protected by high-efficiency scrubbers or high efficiency particulate air (HEPA) filters and vented into a chemical fume hood.

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 vary greatly. For information on specific materials contact EH&S or the manufacturer or check the MSDS.

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 fume hoods and glove boxes and by using personal protective clothing such as gloves and lab coats.

Before beginning work, you can contact EH&S to have the chemical fume hood tested. If a positive pressure glove box 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

Cylinders of compressed gases can pose a chemical hazard as well as a physical hazard. 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

Use toxic, flammable, or reactive gases only in a fume hood or other ventilated enclosure. Use a sensor/detector specific for each toxic gas.

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 for which it was not designed. Regulators are designed to fit only specific cylinder valves to avoid improper use.

Inspect regulators, pressure relief devices, valves, cylinder connections, and hose lines frequently for damage.

Never use a gas cylinder that cannot be positively identified. Color coding is not a reliable way of identifying a gas cylinder because the colors can vary from supplier to supplier.

Do not use oil or grease on any cylinder component of an oxidizing gas because a fire or explosion can result.

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 of which the cylinder is made.

Never completely empty cylinders; rather, leave approximately 25 psi of pressure. This will prevent any residual gas in the cylinder from becoming contaminated.

Position all cylinders so that the main valve is always accessible.

Close the main cylinder valve whenever the cylinder is not in use.

Remove regulators from unused cylinders and always put the safety cap in place to protect the valve.
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.

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.

To transport a cylinder, put on the safety cap and strap the cylinder to a hand-truck in an upright position. Never roll a cylinder.

Always clearly mark empty cylinders and store them separately.

Be careful while handling compressed gas cylinders and never drop or strike a cylinder against anything.

Use only wrenches or other tools supplied by the cylinder supplier to open a valve. Open cylinder valves slowly.

Gas Cylinder Procedure

Because of the tremendous cost involved with the disposal of non-returnable compressed gas cylinders and the potential safety risks associated with unknown cylinders, the University discourages the purchase of any gases in non-returnable cylinders.

All users will be responsible for returning all cylinders to the manufacturer/distributor.

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.

CRYOGENIC MATERIALS

General Characteristics

A cryogenic fluid is a refrigerated, liquefied gas having a boiling point colder than -90 °C (-130 °F) at 14.7 psia absolute.

Some examples are Dry Ice, liquid nitrogen, and liquid oxygen.

Use and Storage
Do not store cryogenic cylinders or Dewars in rooms or environmental chambers that do not have fresh air ventilation. A leak or venting from the container could cause an oxygen-deficient atmosphere.

Do not place cryogenic fluids on tile or laminated counters. They will destroy the adhesive.

Never store Dry Ice in glass or other sealed, air-tight containers or coolers. A pound of Dry Ice sublimes into 8.3 ft³ of carbon dioxide gas in about 1 hour.

Only use containers designed for cryogenic liquids with lids that are vented to allow off-gassing (1 L liquid nitrogen vaporizes to ~0.7 m³ of gas).

Keep liquid oxygen containers, piping, and equipment clean and free of grease, oil, and organic materials.

Always use cryogenic-rated piping and tubing for cryogenic fluids.

Large stationary cryogenic systems and piping have additional requirements. Contact EH&S (817-272-2185) for guidance.

Health Hazards

If a gas is shipped as a liquefied gas under pressure, extreme cold would generally be listed as a secondary hazard, assuming there are more significant (primary) hazards. However, an inert cryogenic liquid is listed as the primary hazard.

First Aid

Remove any clothing not frozen to the skin that may restrict circulation to the frozen area. Do not rub frozen parts, as tissue damage may result. Obtain medical assistance as soon as possible.

Place the affected part of the body in a warm water bath (not to exceed 40 °C). Never use dry heat.

Personal Protective Equipment

Avoid contact with skin and eyes. Wear a face shield, chemical safety goggles, and cryogenic gloves when dispensing from cylinder or Dewar.
Never handle cryogenic materials with your bare hands. Wear appropriate insulated gloves to protect from the extreme cold when handling cryogenic containers. Gloves need to be loose-fitting so that they can be readily removed in the event liquid is splashed into them. Never allow an unprotected part of the body to touch uninsulated pipes or containers of cryogenic material.

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

Goggles provide the best all-around protection against chemical splashes, vapors, dusts, and mists. Goggles that have indirect vents or are non-vented provide the most protection, but you may need to apply an anti-fog agent. Standard safety glasses also provide protection against impact. These glasses are rated ANSI Z87.1.

If using a laser, wear safety glasses or goggles that provide protection against the specific wavelength of that laser and have been approved by the University’s Laser Safety Officer as part of the laser’s standard operating procedure.

Remember, ordinary prescription eyeglasses do not provide adequate protection in a laboratory setting. However, you can purchase prescription safety glasses meeting the ANSI Z87.1 standard from most opticians (LensCrafters, Target, etc.) Also, the University has arranged with a vendor to supply prescription safety glasses to personnel at a reduced cost. Contact EH&S, 817-272-2185, for further information.

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 absolutely necessary to wear contact lenses in a lab, wear protective goggles at all times.

Protective Gloves

Chemicals can permeate any glove. 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.

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.

Check gloves for cracks, tears, and holes before use.

Butyl, neoprene, and nitrile gloves are resistant to most chemicals, such as alcohols, aldehydes, ketones, most inorganic acids, and most caustics.

Disposable latex and vinyl gloves protect against some chemicals, most aqueous solutions, and microorganisms as well as reduce the risk of product contamination.

Leather and some knit gloves will protect against cuts, abrasions, and scratches, but do not protect against chemicals.

Temperature-resistant gloves protect against cryogenic liquids, flames, and high temperatures.

Other Protective Clothing

There are many types of lab coats available. The primary purpose of a lab coat is to protect you from splashes and spills. A lab coat should be nonflammable and be easily removed.

Rubber-coated aprons can be worn to protect against chemical splashes and may be worn over a lab coat for additional protection.

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.

Wear shoes which fully cover your feet. If you plan to perform work that includes moving large and heavy objects such as 55-gallon drums, then you must wear steel-toed shoes.

**C. CHEMICAL SAFETY EQUIPMENT**

Chemical safety equipment includes chemical fume hoods and canopy hoods. Laboratories provide this equipment 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**

There are basically five different types of chemical fume hoods: standard, bypass, auxiliary air, perchloric acid, and radioisotope hoods.

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**

Standard fume hoods consist of a vertically sliding sash (which may have horizontally sliding panes of glass), rear baffle(s), a blower, and ductwork that connects the hood to the blower. 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, typically 18 inches.

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**

Bypass fume hoods 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. 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.

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**

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.

This fume hood design is energy efficient because a smaller volume of conditioned room air is exhausted through the hood.

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**

A perchloric acid fume hood is a special adaptation of a standard, bypass, or auxiliary air fume hood for the use of perchloric acid. 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. 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. As mentioned previously, perchloric acid residues are potentially explosive. 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**

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.

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**

Place equipment and other materials at least six inches behind the sash. This will
reduce the exposure of personnel to chemical vapors that may escape into the lab from air turbulence.

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.

Do not keep loose papers, paper towels, or Kimwipes® in the hood. These materials can get drawn into the blower and adversely affect the performance of the hood.

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.

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.

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.

Keep in mind that modifications made to a fume hood system, for example, adding a snorkel, can render the entire system ineffective.

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.

EH&S inspects chemical fume hoods semi-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 the Hazardous Materials Section at 817-272-2185.

**Canopy Hoods**

Canopy hoods are generally suspended from the ceiling, usually overhanging an exhaust port of some equipment. 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.

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.

**Gloveboxes and Isolators**

Gloveboxes and isolators are used to contain hazardous substances or materials that must not come in contact with the outside environment. Gloveboxes and isolators are used for both protecting personnel and the isolated product by maintaining secure containment fields. These fields are necessary for handling hazardous materials including pyrophorics or toxic compounds.

Gloveboxes and isolators are typically airtight containers that provide oxygen- and moisture-controlled environments. They have specially-sealed ports that are fitted with gloves allowing operators to manipulate the objects and substances inside the isolator.

Gloveboxes and isolators use gloves and gauntlets designed to function in a hazardous environment. The gloves can be made of specially-treated rubber, neoprene, polyurethane, and other materials depending on the application. The gloves may also be treated with electrostatic powder to minimize static electricity.

Gloveboxes and isolators also come with optional features depending on the materials being handled in the containment isolator, such as microprocessor controllers, carbon or HEPA filters, cryogenic traps, gas purifiers, vacuum pumps, and even closed circuit television to monitor experiments.

**References**

1. [UT Arlington EH&S web site - Manuals and Guidelines](#)
2. [Chemical Segregation & Incompatibilities Guidelines](#)
3. [UTA Peroxide Forming Chemical List](#)
4. [Working with Pyrophoric Materials SOP](#)
7. BIOLOGICAL HAZARDS AND CONTROL

Since its publication in 1984, *Biosafety in Microbiological and Biomedical Laboratories* (BMBL) (1) has become the cornerstone of biosafety practice and policy in the United States. The principles of biosafety introduced in the first edition of BMBL and carried through in the fifth edition (2007) address the safe handling and containment of infectious microorganisms and hazardous biological materials. These principles are *containment* and *risk assessment*. The fundamentals of containment include the microbiological practices, safety equipment, and facility safeguards that protect laboratory workers, the environment, and the public from exposure to infectious microorganisms that are handled and stored in the laboratory. Risk assessment is the process that enables the appropriate selection of microbiological practices, safety equipment, and facility safeguards that can prevent laboratory-associated infections (LAI.)

Work with infectious agents has expanded and organizations and laboratory directors are compelled to evaluate and ensure the effectiveness of their biosafety programs, the proficiency of their workers, as well as the capability of equipment, facilities, and management practices to provide containment and security of microbiological agents. Similarly, individual workers who handle pathogenic microorganisms must understand the containment conditions under which infectious agents can be safely manipulated and secured. The use of vaccines may provide an increased level of personal protection. Application of all this knowledge and the use of appropriate techniques and equipment will enable the microbiological and biomedical community to prevent personal, laboratory, and environmental exposure to potentially infectious agents or biohazards.

This section of the UT Arlington Laboratory Safety Manual aims to:

- protect personnel from exposure to infectious agents or other viable biological materials that may cause harm to them or others after secondary transmission;
- protect visitors and others not employed by UT Arlington who may be on the premises or in proximity of biohazards;
- provide an environment for high quality research while maintaining a safe work place; and
- comply with applicable federal, state, and local requirements.

The handling and manipulation of infectious biological agents (bacterial /fungal /parasitic /rickettsial/viral agents, arboviruses & zoonotic viruses, prions, microbial toxins, recombinant DNA molecules, and other viable material) requires the use of precautionary measures. This section of the manual provides assistance in the
evaluation, containment, and control of biohazards associated with safety planning and concerns related to the safe use and handling of biohazardous agents. All personnel, students, volunteers, visiting professionals, or other individuals working with these materials at or on the premises of all UT Arlington facilities should become familiar with this section of the manual and are encouraged to seek additional advice or training when necessary.

A. BIOLOGICAL HAZARDS – EVALUATION

Biological Risk Assessment

Biological risk assessment is an important responsibility for principal investigators of microbiological and biomedical laboratories. Institutional biosafety committees (IBC), animal care and use committees, biological safety professionals, and laboratory animal veterinarians share in this responsibility. Risk assessment is a process used to identify the hazardous characteristics of a known infectious or potentially infectious agent or material, the activities that can result in a person’s exposure to an agent, the likelihood that such exposure will cause a LAI, and the probable consequences of such an infection.

The information identified by risk assessment will provide a guide for the selection of appropriate biosafety levels and microbiological practices, safety equipment, and facility safeguards that can prevent LAIs and protect persons that are not directly associated with the laboratory.

The primary factors to consider in risk assessment and selection of precautions are agent hazards and laboratory procedure hazards. Use careful judgment so that you neither underestimate the risks nor burden the laboratory unnecessarily with too rigorous safeguards.

Agent Hazards

The biological risk assessment should consider the agent’s:

- Biological and physical nature
- Stability in the environment and its endemic nature
- Origin (non-indigenous agents are of special concern because of their potential to introduce risk of transmission or spread of human and animal or infectious diseases from foreign countries into the United States)
- Capability to infect and cause disease in a susceptible human or animal host (host range)
- Infective dose

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• Virulence as measured by the severity of disease
• Probable routes of transmission of laboratory infection
• Availability of preventive measures and effective treatments for the disease.

The agent summary statements contained in BMBL identify the primary agent and procedure hazards for specific pathogens and recommended precautions for their control.

Governmental agencies have performed risk assessments on many wild-type microbial agents. Risk assessments establish a Risk Group (RG) classification that takes into account characteristics of the microorganism and its potential to do harm to health care workers, the public health of the nation, the environment, the national economy, or the agriculture products of the country. Agents are classified into four risk groups according to their relative pathogenicity for healthy adult humans by the following criteria:

<table>
<thead>
<tr>
<th>Risk Group 1</th>
<th>Agents are not associated with disease in healthy adult humans.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Group 2</td>
<td>Agents are associated with human disease, which is rarely serious, and for which preventive or therapeutic interventions are often available.</td>
</tr>
<tr>
<td>Risk Group 3</td>
<td>Agents are associated with serious or lethal human disease for which preventive or therapeutic interventions may be available.</td>
</tr>
<tr>
<td>Risk Group 4</td>
<td>Agents are likely to cause serious or lethal human disease for which preventive or therapeutic interventions are not usually available.</td>
</tr>
</tbody>
</table>

High Risk Individuals/Prenatal Considerations

The principal investigator must determine special hazards and exceptions. The PI is primarily responsible for establishing the safety of personnel under his/her supervision. Persons who are immunocompromised or otherwise particularly susceptible to infection need to be identified so that additional precautions for microbiological safety can be taken when necessary. It may be inadvisable for a person in an immunocompromised condition to work with microorganisms. This includes individuals under systemic corticosteroid therapy, chemotherapy for malignancies, radiation therapy, and those who have certain diseases (for example, lymphomas, leukemia, and AIDS) which induce severe impairment of immune competence. You should seek medical advice regarding possible work restrictions. Any student that has a medical condition that s/he feels might be compromised by exposure to reagents or cultures in the laboratory is encouraged to discuss the matter with her/his PI/supervisor.

Additionally, certain microbes such as *Toxoplasma gondii*, rubella virus, cytomegalovirus, and vesicular stomatitis virus pose a hazard to pregnant women who
should carefully evaluate the risk of working with or near these agents. Toxoplasmosis is a disease acquired from cats that if acquired by a pregnant woman during pregnancy can cause birth defects and other disorders in a fetus. Pregnant women are also known to be at high risk of infection by *Listeria monocytogenes*. Therefore, for her own safety, any female student or staff member who is or thinks that she may be pregnant should discuss the matter with the PI prior to commencing work with *L. monocytogenes*.

Pregnant women can work in animal facilities, but certain tasks may present a hazard to the fetus. Women who become pregnant should notify their PI/supervisor who should consult with a University Health Services physician to review the duties of the pregnant woman.

**Laboratory Procedure Hazards**

The biological risk assessment should consider the potential hazards associated with laboratory procedures:

- Work practices
- Safety equipment
- Facility Safeguards

**Work Practices**

Workers are the first line of defense for protecting themselves, others in the laboratory, and the public from exposure to hazardous agents. Protection depends on using good microbiological practices and using of safety equipment correctly. A risk assessment should identify any potential deficiencies in the practices of the laboratory workers. There may also be hazards that require specialized personal protective equipment in addition to safety glasses, laboratory gowns, and gloves. Principal investigators should train and retrain their staff to the point where aseptic techniques and safety precautions become second nature. Inadequate training in the proper use of personal protective equipment may reduce its effectiveness, provide a false sense of security, and could increase the risk to the laboratory worker.

**Safety Equipment**

Safety equipment such as biological safety cabinets (BSC), centrifuge safety cups, and sealed rotors are used to provide a high degree of protection for the laboratory worker from exposure to microbial aerosols and droplets. Safety equipment that is not working properly is hazardous, especially when the user is unaware of the malfunction. The containment capability of a BSC is compromised by poor location, room air currents, decreased airflow, leaking filters, raised sashes, crowded work surfaces, and poor user
technique. The safety characteristics of modern centrifuges are only effective if the equipment is operated properly. Training in the correct use of equipment, proper procedure, routine inspections, and potential malfunctions, and periodic re-certification of equipment, as needed, is essential.

**Facility Safeguards**

Consideration of facility safeguards is an integral part of the risk assessments. Facility safeguards help prevent the accidental release of an agent from the laboratory. Their use is particularly important at biosafety levels (BSL) 3 and 4 because the agents assigned to those levels can transmit disease by the inhalation route or can cause life-threatening disease. One facility safeguard is directional airflow that helps to prevent aerosol transmission from a laboratory into other areas of the building. Directional airflow is dependent on the operational integrity of the laboratory’s heating, ventilation, and air conditioning (HVAC) system. HVAC systems require careful monitoring and periodic maintenance to sustain operational integrity. Loss of directional airflow compromises safe laboratory operation.

**An Approach to Assess Agent and Procedure Risks and to Select Appropriate Safeguards**

Biological risk assessment is a subjective process that requires consideration of many hazardous characteristics of agents and procedures. BMBL describes a five-step approach that gives structure to the risk assessment process:

*First, identify agent hazards and perform an initial assessment of risk.* Consider the principal hazardous characteristics of the agent, which include its capability to infect and cause disease in a susceptible human host, severity of disease, and the availability of preventive measures and effective treatments.

*Second, identify laboratory procedure hazards.* The principal laboratory procedure hazards are agent concentration, suspension volume, equipment and procedures that generate small particle aerosols and larger airborne particles (droplets), and use of sharps. Procedures involving animals can present a number of hazards such as bites and scratches, exposure to zoonotic agents, and the handling of experimentally generated infectious aerosols. The complexity of a laboratory procedure can also present a hazard.

*Third, make a final determination of the appropriate biosafety level and select additional precautions indicated by the risk assessment.* The final selection of the appropriate biosafety level and the selection of any additional laboratory precautions require a comprehensive understanding of the practices, safety equipment, and facility
safeguards.

Fourth, evaluate the proficiencies of staff regarding safe practices and the integrity of safety equipment. The protection of laboratory workers, other persons associated with the laboratory, and the public will depend ultimately on the laboratory workers themselves. In conducting a risk assessment, the principal investigator should ensure that laboratory workers have acquired the technical proficiency in the use of microbiological practices and safety equipment required for the safe handling of the agent, and have developed good habits that sustain excellence in the performance of those practices. An evaluation of a person's training, experience in handling infectious agents, proficiency in the use of sterile techniques and BSCs, ability to respond to emergencies, and willingness to accept responsibility for protecting oneself and others is important insurance that a laboratory worker is capable of working safely.

The principal investigator (PI) should also ensure that the necessary safety equipment is available and operating properly. For example, a BSC that is not certified represents a potentially serious hazard to the laboratory worker using it and to others in the laboratory. The PI should have all equipment deficiencies corrected before starting work with an agent.

Fifth, review the risk assessment with a biosafety professional, subject matter expert, and the IBC. A review of the risk assessment and selected safeguards by knowledgeable individuals is always beneficial and sometimes required by regulatory or funding agencies. Adopting this step voluntarily will promote the use of safe practices in work with hazardous agents in microbiological and biomedical laboratories.

B. ROUTES OF EXPOSURE

There are four routes of exposure or four ways in which a person can encounter infectious agents. These routes are:

1) direct skin, eye, or mucosal membrane exposure to an agent
2) parenteral inoculation by a syringe needle or other contaminated sharp, or by bites from infected animals and arthropod vectors
3) ingestion of liquid suspension of an infectious agent, or by contaminated hand to mouth exposure, and
4) inhalation of infectious aerosols.

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.

The control of a contact exposure is accomplished through the wearing of appropriate protective clothing such as a face shield, gloves, safety glasses, a mask, and laboratory coats. Other ways to control contact exposure include using absorbent paper on the workbench, performing all procedures carefully, and frequently wiping work surfaces with a disinfectant.

It is also important to keep all non-essential items away from the area where work is being performed to protect personal items from contamination. Handle and store all contaminated wastes properly to prevent contact exposure of lab personnel as well as housekeeping staff and waste handlers.

**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, use it. 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. Simply place the needle and other sharps into a sharps container to prevent any injuries. Contact EH&S at 817-272-2185 for sharps containers.

**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, which then touches 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 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 agent capable of transmitting disease through respiratory exposure to infectious aerosols is a serious laboratory hazard, both for the person handling the agent and for other laboratory occupants. An aerosol can be either 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 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.

C. 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, in other words, 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.

Classification of BSCs

BSCs are designed to provide personnel, environmental, and product protection when appropriate practices and procedures are followed. Three types of BSCs, designated as Class I, II, and III, have been developed to meet varying research and clinical needs.
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 glove boxes. 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 BSL-3 or BSL-4 containment.

Certification of BSCs

The operational integrity of a BSC must be validated before it is placed into service and after it has been repaired or relocated. Relocation may break the HEPA filter seals or damage the filters/the cabinet. Each BSC should be tested and certified at least annually to ensure continued, proper operation.

NSF Standard #49 for Class II BSCs (2) establishes performance criteria and provides the minimum testing requirements that are accepted in the United States. Cabinets that meet the Standard and are certified by NSF bear an NSF Mark.

The purpose and acceptance level of the operational tests ensure the balance of inflow and exhaust air, the distribution of air onto the work surface, and the integrity of the cabinet and the filters. BMBL strongly recommends that accredited field certifiers be used to test and certify BSCs. The certification sticker is fixed to the front glass pane of the BSC.

Working in Class II BSC
A BSC must be used properly to effectively protect the worker and the product. Following are some tips how to work safely in a BSC:

<table>
<thead>
<tr>
<th>WORKING SAFELY IN CLASS II BSC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Plan the experiment and gather all needed materials. Prevent unnecessary opening and closing of room doors when working in the BSC as this will disrupt the airflow. Post a sign on the door stating that the cabinet is in use.</td>
</tr>
<tr>
<td>2) You should not have to penetrate the air barrier of the cabinet once work has begun. In-and-out movement affects the containment air curtain at the cabinet face so place everything necessary inside the cabinet before beginning work, including a waste container.</td>
</tr>
<tr>
<td>3) Only place materials needed for the immediate operation inside of the cabinet. Spare supplies should go outside on a cart. Overloading of the cabinet will affect the airflow adversely.</td>
</tr>
<tr>
<td>4) On initial startup of the blower, allow the cabinet to purge for 5 minutes. Wipe the interior and all supplies with 70% alcohol, 10% bleach, or 1% sodium hypochlorite. A second wipe with sterile water will remove bleach residue.</td>
</tr>
<tr>
<td>5) Always wear lab coat while using the cabinet.</td>
</tr>
<tr>
<td>6) Adjust stool, place arms in cabinet, wait one minute, work at least 4 inches inside of the front grill.</td>
</tr>
<tr>
<td>7) Absorbent toweling/disinfectant soaked towel may be used to reduce splashes/contain any spatters or small spills that might occur. Do not place anything on the air intake grilles, as this will block the air supply.</td>
</tr>
<tr>
<td>8) Reduce in/out movements of arms.</td>
</tr>
<tr>
<td>9) Do not work in the BSC while the ultraviolet (UV) light is on. UV light can quickly injure the eyes.</td>
</tr>
<tr>
<td>10) Open flames are not required in the near microbe-free environment of a BSC. An open flame creates turbulence that disrupts the airflow. When necessary touch-plate microburners equipped with a pilot light to provide a flame on demand may be used. Use disposable sterile loops whenever possible.</td>
</tr>
<tr>
<td>11) Connect aspirator bottles or suction flasks to an overflow collection flask containing appropriate disinfectant, and to an in-line HEPA or equivalent filter. This combination will provide protection to the central building vacuum system or vacuum pump as well as to the personnel who service this system.</td>
</tr>
<tr>
<td>12) Place discards in pans with disinfectant and allow appropriate contact time before removal from cabinet for discard into biohazard boxes.</td>
</tr>
<tr>
<td>13) Alternatively, autoclave prior to disposal. Add water into kill load biohazard bags while still inside the cabinet before removing it for autoclaving.</td>
</tr>
<tr>
<td>14) Surface decontaminate all supplies/equipment before removing them from the cabinet.</td>
</tr>
</tbody>
</table>
WORKING SAFELY IN CLASS II BSC

<table>
<thead>
<tr>
<th>CABINET PROTOCOLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>WORKING SAFELY IN CLASS II BSC</td>
</tr>
<tr>
<td>cabinet. Do a final surface decontaminate on all cabinet surfaces and interior of glass. Remove gloves and wash hands before touching any surfaces outside of cabinet.</td>
</tr>
<tr>
<td>15) Lastly remove gloves, protective clothing, and wash hands and arms thoroughly before leaving the biosafety laboratory area. Operate the cabinet for five minutes after performing any work in it in order to purge airborne contaminants.</td>
</tr>
</tbody>
</table>

Clean Benches

Clean benches are not considered laboratory safety equipment. However, they deserve mention because they may be confused with BSCs. Clean benches direct HEPA-filtered air over the work area to protect biological specimens from particulate contamination by bathing the work area with HEPA-filtered air that is free of particulate contamination. Because they do not provide protection to the user, do not use them in conjunction with biohazardous material, toxins, or radionuclides.

Pipetting Devices

Pipets are among the most commonly-used pieces of equipment in the biological laboratory, and their misuse has been related to a significant number of LAIs. Regrettably, many laboratory workers were taught to pipette by mouth, even after the associated hazards were recognized. With the availability of mechanical pipetting devices, mouth pipetting is now strictly prohibited. Never mouth-pipet, even for innocuous materials because you may, at some time, mistakenly mouth-pipet something that is hazardous. To minimize aerosol production, drain a pipet with the tip against the inner wall of the receiving vessel. Never forcibly expel any hazardous material from a pipette.

Centrifuges, Sonicators, Homogenizers, and Blenders

All of these instruments can create aerosols, and this must be considered with each use. If hazardous materials such as carcinogens, highly toxic, or infectious agents are going to be placed in any of these instruments, then you must take precautions to prevent an exposure of lab personnel to aerosols or liquids.

Centrifuges

Centrifugation is an operation that involves a lot of energy and finely-tuned mechanical instruments. There are many documented cases of occupational lab exposures due to
centrifugation accidents, which nearly always result from aerosol exposure to the room occupants. To minimize the risk of mechanical failure, place centrifuges on a strict maintenance schedule, use according to the manufacturer’s instructions, and routinely inspect to ensure leakage is not occurring. Users should be properly trained in their operation. Safety precautions should be prominently posted on each unit.

Aerosols are also created by practices such as filling centrifuge tubes, removing plugs or caps from tubes after centrifugation, removing supernatant, and re-suspending pellets. Severe aerosol hazards can be created when a tube with infectious materials breaks during centrifugation. To minimize the generation of aerosols when centrifuging biohazardous material, the following procedures should be followed:

**WORKING SAFELY WITH CENTRIFUGES**

<table>
<thead>
<tr>
<th>1) Use sealed tubes placed inside of capped safety buckets (safety cups) that seal with O-rings. Before use, inspect tubes, O-rings, cups, and buckets for cracks, chips, erosions, bits of broken glass, etc. Do not use aluminum foil or any other loose caps to close centrifuge tubes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2) Fill, open, and seal centrifuge tubes, rotors, and accessories inside a BSC. Avoid overfilling of centrifuge tubes so closures will not become wet while spinning in a horizontal or angled position.</td>
</tr>
<tr>
<td>3) After tubes are filled and sealed, wipe them down with disinfectant before placing them in the rotor.</td>
</tr>
<tr>
<td>4) Always balance buckets, tubes, and rotors properly before centrifugation.</td>
</tr>
<tr>
<td>5) Select the type of centrifuge tube (glass type, or plastic-polymer type) that is best suited to the chemicals you will be using and the speed at which you are spinning to avoid melted or shattered tubes.</td>
</tr>
</tbody>
</table>

**Sonicators, Homogenizers, and Blenders**

Operation of these or similar instruments may create hazardous aerosols and lead to exposure of personnel unless you exercise extreme caution. Depending on the nature of the material being used in these instruments, it may be necessary for them to be used or opened only in a BSC. When working with infectious agents, blenders should have leak proof bearings and a tight-fitting, gasketed lid. Inspect the lid and gaskets routinely to ensure that they are in good condition. Household blenders do not prevent the spread of aerosols. In addition, hearing protection may be required while using a sonicator.

**D. PERSONAL PROTECTIVE EQUIPMENT**
Personal protective equipment is defined as specialized clothing or equipment worn by an employee for protection against a hazard. General work clothes (for example, uniforms, pants, shirts, or blouses) are not intended to function as protection against a hazard and are not considered personal protective equipment. The type of personal protective equipment required in microbiological/biochemical laboratories will depend upon the assigned biosafety level (BSL) for that laboratory (see Biosafety Levels section.)

University departments will provide at no cost to the employee, appropriate personal protective equipment to prohibit blood or other potentially infectious materials to pass through to or reach the employee's work clothes, street clothes, undergarments, skin, eyes, mouth, or other mucous membranes under normal conditions of use and for the duration of time that the protective equipment will be used.

All personal protective equipment shall be removed prior to leaving the work area.

**Gowns, Apron and Other Protective Body Clothing**

The protective clothing suitable for a typical undergraduate laboratory is a lab coat to prevent street clothes from being soiled. Restrain long hair if Bunsen burners are in use.

For a typical graduate level teaching or research microbiology lab (which are often a BSL-2), wear lab coats or similar protective clothing while in the lab.

A research lab that is assigned a BSL-3 has additional requirements for personal protective clothing. Laboratory clothing that protects street clothing must be worn, for example, a solid-front or wrap-around gown. Typical lab coats that button down the front are not acceptable because they do not fully protect you.

Leave protective clothing in the lab and do not wear it to other non-lab areas.

**Cleaning, Laundering, and/or Disposal of Personal Protective Equipment**

If a personal protective clothing becomes contaminated (garment is penetrated by blood or other potentially infectious material) it should be removed immediately or as soon as feasible. Contaminated laundry should be handled as little as possible with a minimum of agitation and be bagged (in red bags) or containerized without sorting or rinsing in the location of use. If contaminated laundry is sent to a facility that does not utilize Universal Precautions in the handling of all laundry, the department must ensure that the red bags are labeled with the universal biohazard symbol and the word “biohazard”.

Whenever contaminated laundry is wet and presents a reasonable likelihood of soak-through or of leakage from the bag or container, the laundry should be placed and
transported in bags or containers that prevent soak-through and/or leakage of fluids to the exterior.

Gloves

Gloves must be worn when it can be reasonably anticipated that the employee may have hand contact with blood, other potentially infectious materials, mucous membranes, non-intact skin or any infectious materials.

Disposable, single-use gloves need to be replaced as soon as practical when contaminated or as soon as feasible if they are torn, punctured, or when their ability to function as a barrier is compromised.

Disposable gloves are meant to be used only once and should then be discarded. Latex gloves used in a wet procedure should be replaced after one hour of use. In between glove changes, hands and arms have to be washed thoroughly. Disposable, single-use gloves will not be washed or decontaminated for reuse.

Utility gloves may be decontaminated for reuse if the integrity of the glove is not compromised. However, they must be discarded if they are cracked, peeling, torn, punctured, or exhibits other signs of deterioration or when their ability to function as a barrier is compromised.

Masks, Eye Protection and Face Shields

Masks in combination with eye protection devices, such as goggles or glasses with solid side shields, or chin-length face shields, have to be worn whenever splashes, spray, spatter, or droplets of blood or other potentially infectious materials may be generated and eye, nose, or mouth contamination can be reasonably anticipated. Respirators must be worn in rooms containing infected animals.

E. BIOSAFETY LEVELS

The Centers for Disease Control (CDC) and the National Institutes of Health (NIH) have developed standard procedures providing protection against biological hazards. BMBL (1) 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 Recombinant DNA Molecules (2002) (3) are based on and consistent with the biosafety levels presented here.
A biosafety level (BSL) is based on the potential hazard of the agent and the functions of the laboratory. BSL-1 is for work with agents that pose the least hazard and BSL-4 is for work with agents that pose the greatest hazard. Only BSL-1 and 2 laboratories exist at the UT Arlington. All work with infectious agents at the University should follow the CDC/NIH guidelines. If you are uncertain which biosafety level your work should be performed at, please contact EH&S at 817-272-2185 for assistance.

**Biosafety Level 1**

BSL-1 is suitable for work involving well-characterized agents not known to cause disease in healthy adults, 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.

**Standard Microbiological Practices (BSL-1)**

1. Access to the laboratory is limited or restricted at the discretion of the PI when experiments or work with cultures and specimens are in progress.

2. Persons wash their hands after they handle viable materials, after removing gloves, and before leaving the laboratory.

3. Eating, drinking, smoking, handling contact lenses, applying cosmetics, and storing food for human consumption are not permitted in the work areas. Persons who wear contact lenses in laboratories should also wear goggles or a face shield. Food is stored outside the work area in cabinets or refrigerators designated (and 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," in other words, syringes, needles, Pasteur pipettes, capillary tubes, scalpels, and other sharp instruments or when handling broken glassware to reduce risk of sharps injuries.

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, leak proof 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, 817-272-2185.

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

Special Practices (BLS-1)

None.

Safety Equipment (Primary Barriers) (BSL-1)

- Special containment devices or equipment such as a biological safety cabinet are generally not required for manipulations of agents assigned to BSL-1.

- Protective laboratory coats, gowns, or uniforms are recommended to prevent contamination or soiling of personal clothing.

- Gloves must be worn to protect hands from exposure to hazardous materials. This is especially important if the skin on the hands is broken or if a rash exists.

- Always wear protective eyewear when conducting procedures that have the potential to create splashes of microorganisms or other hazardous materials. You should not wear contact lenses in laboratories.

Laboratory Facilities (Secondary Barriers) (BSL-1)

- Laboratory door(s) are for access control.

- Each laboratory contains a sink for hand washing.
• The laboratory is designed so that it can be easily cleaned. Carpets and rugs in laboratories are not appropriate.

• Laboratory furniture is sturdy. Spaces between benches, cabinets, and equipment are accessible for cleaning.

• Bench tops are impervious to water and resistant to moderate heat, acids, alkalis, organic solvents, and other chemicals.

• If the laboratory has windows that open, they are fitted with insect-proof screens.

Examples of BSL-1 Agents

• *Bacillus subtilis*
• *Escherichia coli*
• Infectious canine hepatitis virus

Biosafety Level 2

BSL-2 builds upon BSL-1 and is suitable for work involving agents of moderate potential hazard to personnel and the environment. It differs from BSL-1 in that

• laboratory personnel have specific training in handling pathogenic agents and are directed by scientists competent in handling infectious agents and associated procedures,
• access to the laboratory is limited when work is being conducted,
• extreme precautions are taken with contaminated sharp items, and
• certain procedures in which infectious aerosols or splashes may be created are conducted in biological safety cabinets or other physical containment equipment.

Standard Microbiological Practices (BSL-2)

Same as BSL-1.

Special Practices (BSL-2)

• Access to the laboratory is limited or restricted by the principal investigator 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 (immunocompromised, immunosuppressed, pregnant women), are not allowed in the laboratory or animal rooms.

- The principal investigator establishes policies and procedures whereby only persons who have been advised of the potential hazard and meet specific entry requirements (for example, appropriate immunization) may enter the laboratory or animal rooms.

- When the infectious agent(s) in use in the laboratory require special provisions for entry, the universal biohazard sign must be posted on the entrance door to the laboratory. The appropriate information to be posted on the entrance door include: biosafety level, list of infectious agent(s), name(s) and telephone number(s) of the principal investigator, contact information after work hours, and any personal protective equipment that must be worn in the laboratory.

- Laboratory personnel receive appropriate immunizations or tests for the agents handled or potentially present in the laboratory (for example, hepatitis B vaccine or TB skin testing).

- 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.

- Site-specific biosafety procedures are prepared and adopted in addition to this UT Arlington EH&S Laboratory Safety Manual. The site-specific procedures should advise personnel about special hazards and practices / procedures that are required to be followed when working in the laboratory.

- Laboratory and support 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.

- Always take a high degree of precaution with any contaminated sharp item, including needles and syringes, slides, pipettes, capillary tubes, and scalpels.

- Restrict needles and syringes or other sharp instruments for use only when there is no alternative, such as parenteral injection, phlebotomy, or aspiration of fluids from laboratory animals and diaphragm bottles.
• Use only needle-locking syringes or disposable syringe-needle units (in other words, needle is integral to the syringe) for the injection or aspiration of infectious materials.

Do not bend, shear, brake, recap or remove needles from disposable syringes, or otherwise manipulate them by hand before disposal. Place used disposable needles and syringes carefully in puncture-resistant containers used for sharps disposal. These sharps containers will be supplied and removed by EH&S for disposal. Place non-disposable sharps in a hard-walled container for transport to a decontamination area, in other words, autoclave room. Do not handle broken glassware directly. Use a brush and dustpan, tongs, or forceps. Plasticware should be substituted for glassware whenever possible.

• Place cultures, tissues, or specimens of body fluids in a container that prevents leakage during collection, handling, processing, storage, transport, or shipping.

• Routinely decontaminate laboratory equipment and work surfaces with an appropriate disinfectant, after you finish work with infectious materials, and especially after overt spills, splashes, or other contamination by infectious materials. Decontaminate equipment 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.

• Immediately report spills and accidents which result in overt exposures to infectious materials to the principal investigator and EH&S, 817-272-2185. Medical evaluation, surveillance, and treatment are provided as appropriate and written records are maintained.

• Animals and plants not involved in work being performed are not permitted in the laboratory.

*Safety Equipment (Primary Barriers) (BSL-2)*

• Properly maintained biological safety cabinets (BSCs), preferably Class II, or other appropriate personal protective equipment or, other physical containment devices are used whenever:

• Procedures with a potential for creating infectious aerosols or splashes are conducted. These may 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 intra-nasally, and harvesting infected tissues from animals or embryos.

- 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.

- Face protection (goggles, mask, face shield or other splatter guards) is used for anticipated splashes or sprays of infectious or other hazardous materials to the face, when the microorganisms must be manipulated outside the BSC.

- 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 (for example, cafeteria, library, administrative offices). All protective clothing is either disposed of in the laboratory or laundered by the institution. It is recommended that personnel do not take laboratory clothing home.

- Gloves are worn when handling infected animals and when hands may contact potentially infectious materials, contaminated surfaces, or equipment.

- Glove selection should be based on an appropriate risk assessment. Alternatives to latex gloves should be available. Wearing two pairs of gloves may be appropriate: if a spill or splatter occurs, the hand will be protected after the contaminated gloves are removed. Change gloves when contaminated, integrity has been compromised, or when otherwise necessary. Remove gloves and wash hands when work with hazardous materials has been completed and before leaving the laboratory. Never wash or reuse disposable gloves. They should be disposed with other contaminated laboratory waste. Disposable gloves are not worn outside the laboratory.

- Emphasize the importance of hand-washing!

*Laboratory Facilities (Secondary Barriers) (BSL-2)*

- Laboratory doors are lockable.

- Each laboratory contains a sink for hand washing.
The laboratory is designed so that it can be easily cleaned. Carpets and rugs in laboratories are inappropriate.

Laboratory furniture is capable of supporting anticipated loading and uses. Spaces between benches, cabinets, and equipment are accessible for cleaning. Chairs and other furniture used in laboratory work should be covered with a non-fabric material that can be easily cleaned and decontaminated.

Bench tops are impervious to water and resistant to moderate heat, acids, alkalis, organic solvents, and other chemicals.

If the laboratory has windows that open, they are fitted with fly-proof screens.

Install biological safety cabinets (BSCs) in such a manner that fluctuations of the room air supply and exhaust do not interfere with proper operations. Locate BSCs away from doors, windows that can be opened, heavily traveled laboratory areas, and other possible airflow disruptions.

HEPA filtered exhaust air form a Class II BSC can be safely re-circulated back into the laboratory environment if the cabinet is tested and certified at least annually and operated according to manufacturer’s recommendations. BSCs can also be connected to the laboratory exhaust system by either a thimble (canopy) or a direct (hard) connection.

An eyewash station is readily available.

A method for decontamination of infectious or regulated laboratory wastes is available (for example, autoclave, chemical disinfection, incinerator, or other approved decontamination system).

There are no specific ventilation requirements. However, planning of new facilities should consider mechanical ventilation systems that provide an inward flow of air without re-circulation to spaces outside of the laboratory.

Examples of BSL-2 Agents

- *Bordetella pertussis*
- *Campylobacter jejuni* subsp. *jejuni*
- *Clostridium tetani*
- *Listeria monocytogenes*
- *Mycobacterium tuberculosis*
Salmonellae
- Shiga toxin-producing *Escherichia coli* strains
- *Shigella* spp.
- *Toxoplasma* spp.
- *Vibrio cholera*
- *Yersinia pestis*
- Hepatitis A & E virus
- Measles virus

**Biosafety Level 3**

BSL-3 is applicable to clinical, diagnostic, teaching, research, or production facilities where work is done with indigenous or exotic agents that may cause serious or potentially lethal disease through inhalation route exposure. 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. **No BSL-3 laboratories exist at UT Arlington at this writing.**

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.

A BSL-3 laboratory has special engineering and design features. It is recognized, however, that some existing facilities may not have all the facility safeguards recommended for BSL-3 (for example, double-door access zone, sealed penetrations, and directional airflow). In these circumstances, acceptable safety may be achieved for routine or repetitive operations (for example, diagnostic procedures involving the propagation of an agent for identification, typing, and susceptibility testing) in BSL-2 facilities, providing:

- the exhaust air from the laboratory room is discharged to the outdoors
- the ventilation to the laboratory is balanced to provide directional airflow into the room
- access to the laboratory is restricted when work is in progress
- the recommended BSL-3 Standard Microbiological and Special Practices are rigorously followed, and Safety Equipment properly used and maintained.

The decision to implement this modification of BSL-3 recommendations should be made only by the principal investigator.

**In addition to all the requirements for BSL-2, work at BSL-3 requires:**

**Special Practices (BSL-3)**
- A laboratory-specific biosafety manual must be prepared. The biosafety manual must be available, accessible, and followed.

- Laboratory doors are kept closed when experiments are in progress.

- The principal investigator controls access to the laboratory and restricts access to persons whose presence is required for program or support purposes.

- The principal investigator is responsible for ensuring that before working with organisms at BSL-3, 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.

- All manipulations involving infectious materials are conducted in biological safety cabinets, or other physical containment devices. No work in open vessels is conducted on the open bench.

- All potentially contaminated materials (for example, gloves, lab coats, etc.) from laboratories or animal rooms are decontaminated before disposal or reuse.

- Spills of infectious materials are contained, decontaminated, and cleaned up by staff properly trained and equipped to work with infectious materials.

- Incidents that may result in exposure to infectious materials must be immediately evaluated and treated according to procedures described in the laboratory biosafety manual. All incidents must be reported to the laboratory supervisor, institutional management and appropriate laboratory personnel as defined in the laboratory biosafety manual. Medical evaluation, surveillance, and treatment should be provided and appropriate records maintained.

**Safety Equipment (Primary Barriers) (BSL-3)**

- Properly maintained biological safety cabinets (BSCs) are used (Class II or III) for all manipulations of infectious materials.

- When a procedure or process cannot be conducted within a BSC, appropriate combinations of personal protective equipment (for example, solid-front or
wrap-around gowns, scrub suits, or coveralls, face protection, gloves, or respirators) and physical containment devices (for example, centrifuge safety cups, sealed centrifuge rotors, or containment caging for animals) are used.

- BSL-3 safety equipment must be used for manipulations of cultures and of those clinical or environmental materials that may be a source of infectious aerosols. These include the aerosol challenge of experimental animals, harvesting of tissues or fluids from infected animals and embryonate eggs, and necropsy of infected animals.

- Respiratory protection is worn when aerosols cannot be safely contained (in other words, outside of a biological safety cabinet), and in rooms containing infected animals.

- Protective laboratory clothing must not be worn outside the laboratory and it must be changed when contaminated. Reusable laboratory clothing needs to be decontaminated before being laundered.

Laboratory Facilities (Secondary Barriers) (BSL-3)

- 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. All doors must be self-closing and lockable. A clothes change room (shower optional) may be included in the passageway.

- Each laboratory contains a sink for hand washing. The sink is foot, elbow, or automatically operated and is located near the laboratory exit door.

- 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.

- All windows in the laboratory are sealed close.

- A method for decontaminating all laboratory wastes is available, preferably within the laboratory (in other words, autoclave, chemical disinfection, incineration, or other approved decontamination method).

- A ducted exhaust air ventilation system is provided. This system creates directional airflow that draws air into the laboratory from "clean" areas and toward "contaminated" areas. The exhaust air is not re-circulated to any
other area of the building. It must be dispersed away from occupied areas and air intakes, or the exhaust must be HEPA-filtered (high efficiency particulate air) or other way treated.

- Laboratory personnel must verify that the direction of airflow (into the laboratory) is proper. This can be achieved using a visual monitoring device that indicates and confirms directional inward airflow at the laboratory entry.

- The HEPA-filtered exhaust air from Class II or Class III biological safety cabinets (BSCs) is discharged directly or through the building exhaust system to the outside. The BSCs must in this case be connected to exhaust system in a manner (for example, thimble unit connection (canopy), or direct connection) that avoids any interference with the air balance of the cabinets or the building exhaust system. HEPA-filtered exhaust air from Class II BSCs may be re-circulated into the laboratory if the cabinet is tested and certified at least annually.

- Equipment that may produce infectious aerosols must be contained in devices that exhaust air through HEPA filtration before being discharged into the laboratory. These HEPA filters should be tested and/or replaced at least annually.

- Vacuum lines are protected with liquid disinfectant traps and HEPA filters, which are routinely maintained and replaced as needed.

- The BSL-3 facility design and operational procedures must be verified and documented prior to operation. Facilities must be re-verified at least annually.

- Enhanced environmental and personal protection may be required if recommended by the agent summary statement, as determined by risk assessment, the site conditions, or other applicable local, state, or federal regulations. These laboratory enhancements may include, for example, an anteroom for clean storage of equipment and supplies with dress-in, shower-out capabilities; gas tight dampers to facilitate laboratory isolation; final HEPA filtration of the laboratory exhaust air; laboratory effluent decontamination; and advanced access control devices such as biometrics.

**Examples of BSL-3 Agents**

- *Bacillus anthracis* (bacterial agent): for work involving production quantities or high concentrations of cultures, screening environmental samples from
anthrax-contaminated locations, and for activities with a high potential for aerosol production.

- *Coxiella burnetii* (rickettsial agent): for activities involving inoculation, incubation, and harvesting of embryonated eggs or cell cultures, necropsy of infected animals, and manipulation of infected tissues.
- *Francisella tularensis* (bacterial agent): during manipulations of cultures and for experimental animal studies.
- *Neisseria meningitis* (bacterial agent): for activities with a high potential for droplet or aerosol production and for activities involving production quantities or high concentrations of infectious materials.
- Yellow fever virus
- West Nile virus

**Biosafety Level 4**

BSL-4 practices, safety equipment, and facility design and construction are applicable for work with dangerous and exotic agents that pose a high individual risk of life-threatening disease, which may be transmitted via the aerosol route and which there is no available vaccine or therapy. Agents with a close or identical antigenic relationship to BSL-4 agents also should be handled at this level. When sufficient data are obtained, work with these agents may continue at this or lower level.

Laboratory staff must have specific and thorough training in handling extremely hazardous infectious agents and understand the primary and secondary containment functions of standard and special practices, containment equipment, and laboratory design characteristics. All laboratory staff and supervisors must be competent in handling agents and procedures requiring BSL-4 containment.

Access to the laboratory is controlled by the laboratory supervisor in accordance with institutional policies.

There are two models for BSL-4 laboratories:

- A *Cabinet Laboratory* where all handling of agents must be performed in a Class III BSC.
- A *Suit Laboratory* where personnel must wear a positive pressure protective suit.

BSL-4 cabinet and suit laboratories have special engineering and design features to prevent microorganisms from being disseminated into the environment.

The standard and special safety practices, equipment, and facilities that apply to BSL-4
are not included in this manual. **No BSL-4 laboratories exist at UT Arlington.**

*Examples of BSL-4 Agents*

- Ebola (*Filovirus*)
- Hendra virus
- Nipah virus
- Omsk Hemorrhagic Fever (*Flavivirus*)

**F. BLOODBORNE PATHOGENS AND UNIVERSAL PRECAUTIONS**

In December 1991, the Occupational Safety and Health Administration (OSHA) promulgated the final rule (4) for occupational exposure to bloodborne pathogens. The rule, commonly referred to as the Bloodborne Pathogen standard, became effective March 6, 1992. The objective is to provide guidelines to eliminate or minimize employee exposure to bloodborne pathogens. Although UT Arlington is not covered by OSHA’s Bloodborne Pathogen standard, we are covered by the Health and Safety Code (5), which requires the Texas Department of State Health Services to establish an exposure control plan designed to minimize exposure of governmental entity employees to bloodborne pathogens.

A human bloodborne pathogen is a pathogenic microorganism present in human blood that can cause disease in humans. Employees face a significant health risk from occupational exposure to blood and other potentially infectious materials (OPIMS) considering that these materials may contain bloodborne pathogens, including Hepatitis B virus (HBV) that causes Hepatitis B, a serious liver disease, and human immunodeficiency virus (HIV), which causes Acquired Immunodeficiency Syndrome (AIDS).

The standard includes the Centers for Disease Control (CDC) guidelines referred to as Universal Precautions. 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.

In an effort to eliminate or minimize exposure to bloodborne pathogens, the standard requires employers to institute:

- a program of engineering and work practice controls,
- personal protective clothing and equipment,
- informational training,
- hepatitis B vaccination,
- post exposure evaluation and follow-up,
- sign and label programs,
and other provisions for employees who may be reasonably anticipated to be exposed to blood or OPIMs during the performance of their duties. Tissue cultures may also unknowingly contain human pathogens, and this is why all human and non-human primate specimens and cell cultures must be handled using Universal Precautions. Even well-characterized cell lines should not be handled with bare hands!

Contact EH&S at 817-272-2185 for information regarding Bloodborne Pathogen training if during the course of your work you have the potential for coming into contact with human blood or OPIMs.

Universal Precautions are summarized below and should be practiced whenever encountering human blood.

<table>
<thead>
<tr>
<th>UNIVERSAL PRECAUTIONS/BLOODBORNE PATHOGENS PRACTICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual training can be taken online. Taking the course online will automatically document completion of the training.</td>
</tr>
<tr>
<td>Identification of those that are at risk is important. If job duties have changed, and you now know that you are at risk, please notify EH&amp;S Office of the change.</td>
</tr>
<tr>
<td>An Exposure Control Plan for Bloodborne Pathogens can be found on EH&amp;S Office website. Review of this manual and completion of the online bloodborne pathogen training meets the Universal Precautions/BBP requirements for research areas.</td>
</tr>
<tr>
<td>Availability of free HBV vaccine and prophylaxis for needle sticks or other exposure incidents involving BBP.</td>
</tr>
<tr>
<td>Extreme sharps precautions, protective clothing and glove use, splash protection, and disinfection: refer to the Special Practices and Safety Equipment (Primary Barriers) section for BSL-2 laboratories in this manual.</td>
</tr>
</tbody>
</table>

**G. LABORATORY ANIMALS**

Some animals can 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" (6) as a primary reference on animal care and use. The goal of the Guide is to promote 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 (7) and Public Health Service Policy on Humane Care and Use of Laboratory Animals (8).

Departments conducting animal research must have an effective occupational health and safety program that 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.

The Institutional Animal Care and Use Committee (IACUC) is a peer review committee that is charged with reviewing research protocols for the humane use of experimental animals. The IACUC must approve the work before experimental animals can be purchased. When the animal research involves biohazards, the investigator must receive approval from the Institutional Biosafety Committee (IBC) for that agent's use in animals, before the IACUC can approve the animal work. Work with experimental animals is thus strictly regulated. Only those authorized can enter animal facilities or work with experimental animals in that facility. Access to animal facilities is controlled by ID badge key card entry. Before key card is activated, personnel must deliver and document animal operational and safety training.

Wear gloves, masks, and laboratory coats whenever entering an area where experimental 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 EH&S at 817-272-2185.

H. EMERGENCY PROCEDURES

Refer to the Emergency Procedures and Equipment: Special Procedures for Biological Hazard spills section of this manual for important information on emergency procedures. 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 BSL-2 agent. In the section, some specific instructions are given for the cleanup of a biological spill.

I. WASTE DISPOSAL

There are many types of waste generated in a microbiological laboratory and all need to be handled, treated, stored, and disposed of properly. Please, refer to the “Biological (or Special) Wastes” section of this manual.
8. **RADIATION HAZARDS AND CONTROL**

The University’s Radiation Safety Manual covers radiation hazards and control, to include radioactive materials, radiation-producing machines, and laser devices.

The topics included in the manual are:

- Radiation safety program management
- Radiation facilities and equipment
- Operational radiation safety procedures
- Radioactive material accountability
- Radiation instrumentation
- Required tests and records
- Radioactive waste management and disposal
- Emergency procedures
Contact the Radiation Section of EH&S at 817-272-2185 for copies of the manual and/or to schedule required Radiation Safety or Laser Safety Training.

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

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

### Introduction

The objective of the implementation of a Memorandum of Understanding (MOU) is to define an institutional policy for the use of controlled items (chemical precursors and certain lab apparatus) on the campus of The University of Texas at Arlington (UT Arlington). This procedure applies to all laboratories at UT Arlington and is written in accordance with the MOU issued by the Texas Department of Public Safety (DPS) and the Texas Higher Education Coordinating Board (THECB), which became effective March 1, 1996, and revised June 13, 2006.

### Scope

This guidance document 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. Each Principal Investigator (PI) at UT Arlington intending to work with controlled substances shall apply for and receive an individual researcher registration from the U.S. Drug Enforcement Agency (DEA) and DPS. Each authorized registrant shall be directly responsible to the DEA and Texas DPS for the accurate logging, dispensing and security of controlled substances under their charge. Under no circumstances shall registrants dispense drugs to others without first ensuring procedural compliance with DEA regulations and a valid chain of custody is documented. Each registrant’s records are subject to audit by EH&S. Additionally, the DEA may audit records and procedures used by each registrant, acting as the regulatory authority over the registrants. Procurement, logging of use, transfer, secure storage and disposal shall strictly follow the procedures outlined below.
The following is a list of the controlled items whose purchase, use, and disposal must be monitored:

A. LIST OF PRECURSOR ITEMS

<table>
<thead>
<tr>
<th>Precursor Chemicals</th>
<th>Laboratory Apparatus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methylamine</td>
<td>Condensers</td>
</tr>
<tr>
<td>Ethylamine</td>
<td>Distilling apparatus</td>
</tr>
<tr>
<td>D-lysergic acid</td>
<td>Vacuum dryers</td>
</tr>
<tr>
<td>Ergotamine tartrate</td>
<td>Three-necked flasks</td>
</tr>
<tr>
<td>Diethyl malonate</td>
<td>Distilling flasks</td>
</tr>
<tr>
<td>Malonic acid</td>
<td>Tableting machines</td>
</tr>
<tr>
<td>Ethyl malonate</td>
<td>Encapsulating machines</td>
</tr>
<tr>
<td>Barbituric acid</td>
<td>Filter funnels, buchner funnels, and</td>
</tr>
<tr>
<td>Piperidine</td>
<td>separatory funnels</td>
</tr>
<tr>
<td>N-acetylanthranilic acid</td>
<td>Erlenmyer flasks, two-necked flasks,</td>
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<tr>
<td></td>
<td>single-neck flasks,</td>
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<tr>
<td></td>
<td>round-bottom flasks, Florence</td>
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<tr>
<td>Pyrrolidine</td>
<td>flasks, thermometer flasks, and</td>
</tr>
<tr>
<td>Phenylacetic acid</td>
<td>filtering flasks</td>
</tr>
<tr>
<td>Anthranilic acid</td>
<td>Soxhlet extractors</td>
</tr>
<tr>
<td>Hypophosphorus acid</td>
<td>Transformers</td>
</tr>
<tr>
<td>Ephedrine</td>
<td>Flask heaters</td>
</tr>
<tr>
<td>Pseudoephedrine</td>
<td>Heating mantles</td>
</tr>
<tr>
<td>Norpseudoephedrine</td>
<td>Adapter tubes</td>
</tr>
<tr>
<td>Phenylpropanolamine</td>
<td>Condensers</td>
</tr>
<tr>
<td>Red phosphorus</td>
<td>Distilling apparatus</td>
</tr>
</tbody>
</table>

The MOU, which was signed by the Director of the DPS and the Commissioner of the Texas Higher Education Coordinating Board, commits the University to establish procedures that specify:

- personal responsibility for secure use of controlled items;
- record-keeping requirements for purchases;
- procedures for disposal of unused controlled items;
- security procedures governing use of the controlled items; and
- liaison between the University and DPS.

As written in the MOU, “the institution or site shall prohibit the sale, furnishing, or transfer of controlled items, including glassware, covered by this MOU to any person or entity not holding a DPS permit, unless the recipient is specifically exempted by law or rule.” Full compliance with this Memorandum is required.

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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 PI therefore becomes 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. Sharing of drug materials with non-registrants is strictly prohibited. Sharing of drug materials with registrants not approved for a specific listed drug is also prohibited. Registrants will ensure that only the registrant or his/her DEA approved designee (Power of Attorney required) will place the order for DEA controlled substances. Under no circumstances will the registrant allow the academic department’s office staff to call in the order for DEA controlled substances. Drugs shall be delivered by the shipper directly to the registrant or his/her DEA approved designate. Under no circumstances can UT Arlington personnel sign for and/or receive a package of DEA controlled substances for delivery. Should the registrant or his/her DEA approved designate not be available, the package will be refused and returned to the shipper. Registrants shall sign for receipt of the drugs ordered and initiate a usage log for the material purchased and received. Additionally, the invoice or DEA form 222 MUST be initialed and dated the day the material was received. If possible, also get a witness to initial receipt date on the invoice.

C. PURCHASE ORDERS

Registrants wishing to procure or otherwise acquire a listed drug shall first ensure that it is one for which they are currently registered. Authorized registrants shall only procure or otherwise control inventories that are directly related to teaching or research activities. Procurement Services 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 Procurement Services on a purchase requisition form. RPs 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 EH&S; any laboratory apparatus listed on the MOU will be destroyed by EH&S. The Supervisor of the University's Surplus Property will inform EH&S of any controlled items that come in for sale. EH&S will pick up these items and disposed of them properly.

**E. DISPOSAL**

DEA controlled substances that have expired or otherwise remain unused and are no longer needed by the registrant shall be disposed of through EH&S, via the UT System hazardous waste contractor registered with the DEA as a Reverse Distributor; who is authorized to take possession of Controlled Substances and destroy them at their incineration facilities.

**F. SECURITY PROCEDURES GOVERNING USE OF CONTROLLED ITEMS**

Controlled item security consists of site security, operational security, written inventory monitoring log, 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 Commission on Environmental Quality (TCEQ). The procedures for storage and handling of controlled items must also adhere to all applicable state and federal laws.

**G. SITE SECURITY**

Drugs shall be stored within the DEA approved safe solely under the control of the registrant. The location of this safe is subject to approval by the institution and DEA. The facility or room where the safe is stored shall be secured when the registrant or his/her direct report is not present. UT Arlington Police Department is available to assist in evaluating and making recommendations regarding site security.

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

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.

H. OPERATIONAL SECURITY

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.

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.

I. INVENTORY AND REPORTING OF LOSS

The existence of the institutional record or copies does not in any way relieve the DEA registrant of his/her direct responsibilities under the federal regulations for documentation of receipt, usage or destruction. The registrant shall continually maintain usage logs in a manner available for inspection by the DEA regulatory authority and/or EH&S. Written prudent procedures must be established by the RP to quantitatively monitor the consumption and use of the controlled items. These procedures should be available for inspection by DEA, DPS and EH&S personnel at any time.

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. In the event of a security breach to the laboratory involving theft and or loss of DEA controlled substances, the registrant must immediately report (within the next business day) the event to the UT Arlington Police Department (UTPD) at 272-3003 and EH&S. EH&S, UTPD and the registrant will immediately conduct an inventory of the controlled substances on hand. Any theft or loss will be reported to the DEA on Form DEA-106.

In the event of a security breach to the laboratory which is discovered by UTPD or reported to UTPD by someone other than the registrant, the UTPD will file a report and notify EH&S. EH&S will immediately initiate attempts to contact the registrant either at his/her UT Arlington Laboratory, UT Arlington office, at home and or cell phone. EH&S, UTPD and the registrant will then conduct an inventory of the controlled substances on hand. Any theft or loss will be reported to the DEA on Form DEA-106.

J. 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.

Reference/ Forms

1. A Memorandum of Understanding (MOU) in accord with Health and Safety Code, Section 481.0621 (b) [http://www.thecb.state.tx.us/reports/PDF/1210.PDF](http://www.thecb.state.tx.us/reports/PDF/1210.PDF).
2. Record of Controlled Substances Administered/Dispensed form.
3. Controlled Substances Biennial Inventory Record form.

10. CHEMICAL WASTE

A. HAZARDOUS WASTES

A hazardous waste is a waste that can, by U.S. Environmental Protection Agency (EPA) 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 EH&S 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 have been 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 EH&S at 817-272-2185.

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. Therefore, return cylinders as soon as possible after they are depleted and do not keep a cylinder no longer than three years. Return all cylinders containing corrosive or reactive gases (for example, 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. Gases should be purchased in cylinders that can be returned to manufacture to prevent expensive disposal cost.

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.

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 depend on the previous contents and the efficiency of emptying them. Containers of pourable contents must be completely emptied, in other words, 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 EH&S Hazardous
Material Section.

If containers are not or cannot be emptied or if they contain acutely hazardous waste, submit them to 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 pickup 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 Facilities Management Custodial Services. Please contact a supervisor in Custodial Services (817-272-2602) to obtain the “glass only” puncture-resistant containers.

F. PCB LIGHT BALLASTS

Commercial polychlorinated biphenyls (PCBs) 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 EH&S at 817-272-2185 and Facilities Management at 817-272-3571.

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, leave both the fixture and ballast in place. An 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 EH&S Hazardous Materials Section (817-272-2185). The electrician will need to be present when EH&S response team arrives.

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

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

**G. BATTERIES**

Alkaline batteries can be recycled through the UT Arlington recycling program (Office of Sustainability). 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**

Dispose of used oils and oil filters from shops or laboratories 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 Hazard Materials Section's accumulation facilities. Pickups 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 located in APPENDIX III.

**J. RADIOACTIVE WASTE**

A number of government statutes and regulations govern the disposal of radioactive waste. Before attempting to dispose of any such waste, contact both EH&S Radiation
Section and/or 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 EH&S at 817-272-2185.

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. 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 questions contact EH&S, 817-272-2185.

11. BIOLOGICAL (OR SPECIAL) WASTES

A. DEFINITION OF BIOLOGICAL (OR SPECIAL) WASTE

The Texas Board of Health has identified biological or special waste as requiring special handling to protect human health or the environment. The Board further defined a solid waste as waste that if improperly treated or handled may serve to transmit infectious disease(s).

The term “biological (or special) waste” refers to regulated waste, including the following:

- microbiological waste
- sharps
- human blood, blood products, and other potentially infectious materials
- pathological waste
- bedding of animals intentionally exposed to pathogens
- animal waste

The Texas Commission on Environmental Quality (TCEQ) (1) and the Texas Department of State Health Services (TDSHS) (2) regulate biological waste.
B. RECORD KEEPING

Personnel who treat and dispose special wastes onsite in accordance with the guidelines described in this section must keep the following records:

- date of treatment (also time for incineration)
- amount of waste treated
- method/conditions of treatment
- name (printed) and initials of person(s) performing treatment
- for generators of more than 50 pounds per month, 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

Personnel must maintain records for three years and must have them available for review on request.

C. MICROBIOLOGICAL WASTE

Microbiological waste includes:

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

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

Microbiological waste can either be treated on-site in the laboratory or can be given to EH&S for disposal. Complete the form at this link [http://www.uta.edu/policy/forms/ehs/8-28.pdf](http://www.uta.edu/policy/forms/ehs/8-28.pdf) and email it to EH&S.

**Treatment Methods**

Acceptable methods of treatment and disposal of microbiological waste at UT Arlington include steam sterilization, chemical disinfection, and incineration.

*Steam Sterilization*
To allow sufficient steam access/penetration to the waste, the waste shall be packaged and loaded into the autoclave chamber according to the instructions given by EH&S in the “Safe Operating Procedure for Steam Autoclaves”, section “Autoclaving Biohazardous Waste Materials”, and autoclave operated according to the recommendations provided by the manufacturer.

When subjecting waste to steam under pressure:

- the temperature in the autoclave chamber must reach at least 121°C (250°F)
- the gauge pressure must be at least 15 pounds per square inch (psi)
- the treatment time must be at least 30 minutes

EH&S will check autoclaves' performance used for waste treatment. The efficacy is monitored with a biological indicator (Geobacillus stearothermophilus spores) at an appropriate frequency to ensure that the sterilization parameters are effective in treating biohazardous waste.

Chemical Disinfection

Use a chemical agent that is registered with the U.S. Environmental Protection Agency as a surface disinfectant in accordance with the manufacturer's instructions.

When immersing the waste in a liquid disinfectant, the treatment time should be at least three minutes in:

- a freshly prepared solution of household bleach diluted 1:10 with water or
- a solution of 70% by volume 2-propanol (isopropyl alcohol)

Waste that has been immersed in a liquid disinfectant must be thoroughly drained before disposal.

Disposal of Steam Sterilized or Chemically Disinfected Waste

Microbiological waste that 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:

- place a label on the original bag or container stating "Treated in accordance with the provisions of 25 TAC §1.136(a)" (2) relating to approved methods of treatment and disposition available through EH&S
• place the bag or other container into another bag or container that is a different color and is opaque, e.g., a black or green trash bag

If treated waste is in a liquid form it can be disposed of through the sanitary sewer.

Note: If you are unable to treat and dispose of microbiological waste yourself, contact EH&S at 817-272-2185 for assistance.

Incineration

The incinerator is located on the roof of the Life Science Building. The above listed information in this section (“Record Keeping”) about the incineration must be entered in the log books located in the Biology Office or in the Animal Care Facility.

Operational procedures for the use of the incinerator

• The incinerator is designed to destroy up to 100 pounds per hour of biological waste. Do NOT overload the incinerator.
• Operate the incinerator only during daylight hours.
• Do not burn aerosol cans, closed containers, or flammable liquids.
• Do not attempt to burn paper such as office records, computer paper, or telephone books.
• Weigh waste, and log pounds (lb.) of waste in the log in addition to date, time, operator info, and description of incinerated waste.
• When loading 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.
• Do not open the door or add more trash until the load has burned down. This could cause two problems:
  • overloading of the incinerator
  • the possibility of explosion which could injure the operator
• If the main charging door is opened while the incinerator is operating, the primary burner will be shut off by the door safety switch.
• Always open and close charging door slowly to avoid flame and smoke puffs.
• Do not use water to cool hot refractory or brick.
• If ashes build up above the bottom of the burner port or obstruct air passages, contact EH&S to arrange the cleaning of the incinerator.

D. SHARPS

Sharps that are considered special waste include
• hypodermic needles
• hypodermic syringes with attached needles
• scalpel blades
• razor blades
• disposable razors
• Pasteur pipettes
• broken glassware 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 listed items shall be disposed of as infectious waste and deposited into the sharps containers available through EH&S. EH&S will deliver, pick up, and dispose of sharps containers to any departments or laboratories at no charge. In order for the containers to be picked up, a request for disposal (Request for Disposal Form - Biological Waste and Sharps) should be completed by following the instructions on the form and sent to EH&S.

Sharps containers will be kept in each work area that generates sharps and the following rules followed in connection to the work with sharps:

• to avoid accidental sticks hypodermic needles must be placed directly into the containers and not recapped, bent, broken, clipped, or removed from disposable syringes
• do not attempt to treat (decontaminate) sharps yourself for any biohazard
• do not overfill the containers (they should not be more than ¾ full when picked up)
• do not dispose of these containers with the regular trash
• do not incinerate sharps containers

E. HUMAN BLOOD, BLOOD PRODUCTS, AND OTHER POTENTIALLY INFECTIOUS MATERIALS

Human blood and blood products means:

• discarded waste human blood
• serum
• plasma
• other blood components, materials containing free-flowing blood and blood products

The following human body fluids are referred to as “other potentially infectious materials” (OPIMs) considering that these materials may also contain bloodborne
pathogens, including HBV that causes hepatitis B, a serious liver disease, and human immunodeficiency virus (HIV) that causes acquired immunodeficiency syndrome (AIDS).

- semen
- vaginal secretions
- cerebrospinal fluid
- synovial fluid
- pleural fluid
- pericardial fluid
- peritoneal fluid
- amniotic fluid
- saliva (in dental procedures)
- any body fluid that is visibly contaminated with blood
- all body fluids in situations where it is difficult or impossible to differentiate between body fluids

All human blood, blood products, and OPIMs 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 EH&S, 817-272-2185.

F. PATHOLOGICAL WASTE

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

G. BEDDING OF ANIMALS INTENTIONALLY EXPOSED TO PATHOGENS AND ANIMAL WASTE

Dispose of all bedding of animals intentionally exposed to pathogens, animal carcasses, body parts, and blood and blood products in the incinerator located on the roof of the Life Science Building. Double-bag all animal waste to prevent leakage when transporting it to the incinerator. If you need special assistance regarding incineration contact EH&S, 817-272-2185 or the Animal Care Facility, 817-272-5236.

REFERENCES

1. The Texas Commission on Environmental Quality (TCEQ) rules: 30 Texas Administrative Code (TAC), Chapter 330.

2. The Texas Department of State Health Services (TDSHS) rules: 25 Texas
12. DISPOSAL OF CHEMICAL WASTE

A. SANITARY SEWER DISPOSAL

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

- Flammable and combustible solvents including benzene, toluene, xylenes, hexane, acetone, ethers, formaldehyde, tetrahydrofuran, and ethyl acetate.

- Halogenated solvents including chloroform, dichloromethane, carbon tetrachloride, and chlorinated fluorocarbons.

- Phenolic and amine compounds including phenols, hydroquinone, acrylamide, and ethanolamine.

- Corrosive materials including sulfuric acid, hydrochloric acid, acetic acid, sodium hydroxide, and potassium hydroxide.

- Aqueous solutions containing regulated quantities of arsenic, barium, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, or zinc.

- Cyanide and sulfide compounds including organic nitriles and mercaptans.

- Poisons including bromine, ethidium bromide, benzidine, and osmium tetroxide.

- Explosive compounds including picric acid and organic peroxides (see APPENDIX III for other examples).

- Commercial products including strippers, paints, dyes and some concentrated cleaners.

- Radioactive materials.

- Untreated liquid special (biological) waste.
Do NOT flush acid or base solutions containing organic or inorganic impurities (for example, base baths or acidic solutions used to clean glassware) down the drain; collect these solutions for disposal by EH&S. If you have any questions about sink disposal of any material, contact the Hazardous Materials Section of EH&S at 817-272-2185 for assistance. Violations of the City of Arlington wastewater discharge permit or other waste disposal regulations could result in interruption of laboratory activities, financial penalties, or prison sentences.

B. STORM SEWER DISPOSAL

The storm sewer system is designed to carry runoff 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 EH&S at 817-272-2185.

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

C. WASTE CONTAINERS

Containers holding waste must have a lid, be in good condition, not leaking, and compatible with the waste being stored. Keep the container closed during storage, except when you add waste. Do not place hazardous waste 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, you must transfer the waste from this container to a container that is in good condition. Please contact EH&S Hazardous Materials Section, 817-272-2185, if you require assistance.

EH&S Hazardous Materials Section will provide 6 or 10-liter Nalgene® containers for laboratories generating large quantities of liquid hazardous waste that is bulked by EH&S.

Separate store a storage container holding a hazardous waste that is incompatible with any waste or other materials stored nearby. A wall or partition will suffice.

All waste containers must be:

- 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. Complete this tag when you add waste to the container. EH&S cannot pick up the hazardous waste without this completed tag.

- Kept at or near (immediate vicinity) the site of generation and under control of the generator.

- Compatible with contents (for example, acids should not be stored in metal cans).

- Closed at all times except when waste is added to container.

- Properly identified with completed waste tags.

- Safe for transport with non-leaking screw-on caps.

- Filled to a safe level (not beyond the bottom of the neck of the container or a 2-inch headspace for 55 gallon drums). Do not overfill waste containers. Over-filled bottles are:
  - hard to pour safely,
  - inclined to burst,
  - likely to leak, and
  - capable of endangering the operator through splashing or shooting up into one’s face upon opening.

D. WASTE ACCUMULATION

An important step in the chemical disposal sequence involves the temporary storage of waste at or near the point of generation. A generator of possible hazardous waste at a satellite accumulation area (SAA) may accumulate up to a total of 10 liters of each type solvent waste, which may be determined to be hazardous by EH&S, or one quart of listed acutely hazardous waste (see APPENDIX VI). All solvent waste containers stored at a SAA must be in secondary containment. Except when single chemicals are accumulated for recycling or recovery, waste accumulation generally involves bulking several materials into one container. For example, compatible solvents and other organic liquids can be consolidated since they are bulked into a 55-gallon drum for transportation off-site at the EH&S accumulation center.
Please adhere to the following guidelines for safe accumulation of chemical waste:

- Clearly mark containers and date them when accumulation starts at the SAA. Use the pre-labeled hazardous waste containers that are available from EH&S. Date containers when accumulation begins.

- Label containers with words that clearly identify the contents the FIRST time you put waste into them. Generic names like "Waste Organics" are acceptable, but keep in mind that you must complete a waste characterization sheet (WCS) listing ALL of the chemical components before EH&S can accept the waste for off-site disposal.

- Separate incompatible wastes streams.

- Keep waste collection containers closed at ALL times during storage except when adding or removing waste. This is true for solids as well as liquids. Many containers, like beakers or flasks, for example are not acceptable accumulation containers.

- Designate an area in your lab as a chemical waste accumulation area. Using a hood for this purpose is ok, so long as there are no experiments in the hood.

- Contact EH&S for removal of full waste containers from the laboratory. Do not allow large quantities of waste to accumulate in the hoods.

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:

- Collect miscellaneous solids, for example, gloves, rags or towels, and other lab debris separately from liquid wastes.

- Halogenated solvents, such as methylene chloride, chloroform, carbon tetrachloride.

**Note:** Disposal of non-halogenated solvents contaminated with halogens costs 4-5 times as much as non-halogenated solvents.
• Non-halogenated solvents such as xylene, toluene, and alcohols.

• 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 PCBs.

• Acids

• Bases

• 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.

• Accumulate waste that is both flammable and corrosive separately from waste that is either flammable or corrosive.

• Collect some kinds of wastes, such as cyanide, sulfide, pesticides, oxidizers, organic acids, explosives, peroxides, and acute toxins, individually whenever possible.

E. WASTE CONTAINER LABELING

Before EH&S can pick up any chemical waste, a Hazardous Chemical Inventory Tag (see APPENDIX-IX) is required. Fill it out and attach it to each waste container. Use the information on the tag to categorize and treat the waste. Please fill it out legibly, accurately, and completely (see APPENDIX IXa for a sample completed 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 number, and phone number.

• Indicate overall volume or weight - Write in the total volume or weight of material in the container.

• Specify Chemical Contents – List the specific, full chemical name (no formulas or abbreviations) for each chemical constituent in this container.
Product names or trade names are acceptable if you can supply the manufacturer’s name and address or an MSDS 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 pickup until sufficiently detailed information is submitted to EH&S.

- **Amount** - Total volume or weight of each chemical constituent in the container.
- **Volume %** - 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 EH&S Hazardous Materials Section 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 CEMS:**
   
   Log into the Chemical Environmental Management System (CEMS) [http://cems.uta.edu](http://cems.uta.edu). Sign-in by selecting your name and using your CEMS password. Click “request waste removal” in the section “Hazardous Waste” of the “My Responsibilities” window.

2. **via email to:**

   The online Request for Disposal Hazardous Chemicals is available at the following link, [http://www.uta.edu/policy/form/index/chemical/](http://www.uta.edu/policy/form/index/chemical/)

   or

3. **via Campus Mail to:**

   Hazardous Materials Section
   Environmental Health & Safety
   Box 19257
or

4. via Fax to:

Hazardous Materials Section
Environmental Health & Safety
817-272-2144

Send a Request for Disposal - Hazardous Chemicals form at least five working days prior to reaching the accumulation limits referenced in Section D above.

EH&S makes pickups regularly and will come to your site within three working days (72 hours) of receiving your request. 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 IXa is a sample completed 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. The individual must be a UT Arlington employee.
- Department - Name of department generating the waste.
- Box - Five character code for campus mail. See the front of the UT Arlington 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. See the instructions above.
- Percentage (%) of Container - 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%).

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

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

- **Name** - 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. This person must be a UT Arlington employee (for example, faculty, staff, TA, or RA).

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

Complete biological waste or sharps requests for disposal 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.

- **Buy 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.

- **Rotating stock** to avoid outdated chemicals.

- **Properly storing** chemicals to prevent aging or, worse yet, spills and fires.
• Handle lab spills properly to minimize personal danger and the volume of waste material generated because of such spills.

• Plan experiments with waste minimization in mind.

• Substitute less hazardous materials during any step of an experiment.

• Know what is and what is not a "hazardous chemical."

• Protocols in the lab should include proper waste segregation and containerization so that disposal options can remain clearer and more cost effective.

• The facts on the waste forms should be true and complete.

• Prevent "unknowns" by keeping containers labeled.

• Look internally for a needed chemical before buying a fresh bottle.

• Explore possible new procedures and/or equipment modifications aimed at reducing waste generation.

B. SPECIAL OPTIONS FOR EDUCATIONAL INSTITUTIONS

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

Improved Material Management Practices

• 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.

• Encourage 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.

• 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.

- **Rotate chemical stocks** using chemicals before their shelf life expires (first-in-first-out stock usage).

- **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.

- **Appoint a safety and waste management officer** for each department to work with EH&S. Centralizing responsibilities will facilitate a coordinated and efficient implementation of regulations, institution policy, and waste reduction goals.

- **Educate professors, students, and staff on the benefits of waste reduction.** This should include instruction on specific techniques for reducing waste generation.

- **Establish annual goals for institution-wide and departmental waste reduction.** First, determine past yearly totals of waste generation, and then assess economic and technical feasibility for establishing and achieving specific reduction goals.

- **Provide routine self-audits** for laboratories, professors, students, and staff to minimize reagent accumulation and maximize recycling.

**Improved Laboratory Practices**

- **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.

- **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.

- *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.

- *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.

- *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.

- *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 an awareness of proper waste management and waste reduction. Some chemical wastes can be destroyed by students as a step in experiments.

- *Keep individual waste streams segregated.* Keep hazardous waste segregated from nonhazardous waste. All waste contaminated with a hazardous substance must be treated as hazardous waste. Keep recyclable waste segregated from non-recyclable waste.

- *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**

- *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.

- *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. 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.

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

14. Chemical Environmental Management System (CEMS)

The University of Texas at Arlington utilizes The Chemical Environmental Management System (CEMS), a barcode-based system, to record and manage information about the quantity, location and properties of chemical stock, biological agents, and hazardous waste. It has the capability to automate record-keeping and waste removal requests for material in its original container, allows campus labs to share materials, and can broadcast messages.

Key features and benefits of CEMS that users can take advantage of include:

- Saving money and space by reducing or completely eliminating unnecessary purchases; saves time by maintaining stock at an appropriate level.
- Increases efficiency by making chemicals easy to locate.
- Maintaining a current and up to date inventory of all chemicals.
- Calculates total amount of certain chemicals to comply with the Department of Homeland Security’s Chemical Facility Anti-Terrorism Standards.
• Provides access to more than 23,000 material safety data sheets (MSDS) updated regularly.

• Knowing when to remove old or expired chemicals by identifying chemicals with specific shelf life and specific storage requirements.

• Request chemical waste removal.

EH&S personnel can use CEMS to provide periodic reports to emergency service providers. Equipped with this information, EH&S can provide support to firefighters or hazmat teams if they respond to a spill or fire in a laboratory. Some of the potential chemical hazards that could be found in a lab may include: flammable materials, water reactive, corrosive or explosive. Information on chemicals in surrounding rooms would be vital information to emergency responders and can also be obtained from CEMS. Inventory updates can be performed quickly with a hand-held PC and a scanner.

http://cems.uta.edu/

Selected Bibliography


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STANDARD OPERATING PROCEDURE
ETHIDIUM BROMIDE USE AND DISPOSAL

INTRODUCTION

Although ethidium bromide (EtBr) is not regulated as a hazardous waste, its mutagenic properties may present a human health hazard if it is placed in the trash or poured down the sanitary sewer system. Use the following procedures when working with or disposing EtBr solutions, gels, or other contaminated materials.

SAFE HANDLING

Store EtBr and EtBr stock solutions away from strong oxidizing agents (e.g. nitric acid) in a cool, dark, dry place. Stock solution bottles should be kept in a robust liquid proof secondary container when not in use. Make sure that the stock solution bottles are of a type that is not easily knocked over. As with all chemicals, containers of EtBr should be kept tightly closed.

All procedures involving pure EtBr, concentrated EtBr stock solutions, or EtBr gels should be performed in a chemical fume hood.

For incidental contact with EtBr (minimum potential for splash and exposure), wear safety glasses with side shields and brow guard protection or goggles, double nitrile gloves, and a non-porous lab coat. If your outer gloves become contaminated, replace them immediately with clean ones.

For prolonged contact, work involving concentrated solutions, spill cleanup, or large quantities of EtBr, wear chemical splash goggles, double nitrile gloves, and an impervious chemical-resistant or polyvinyl chloride apron/smock/lab coat. Avoid using the traditional cotton-polyester white lab coat that readily collects/absorbs compounds. If your outer gloves become contaminated, replace them immediately with clean ones.

Also be sure to remove your gloves when handling non-lab items such as telephones or keyboards.

Natural rubber latex gloves do not provide a suitable barrier to EtBr penetration.

EtBr should only be added to molten agarose solutions when the latter have been allowed to cool below 50°C. This prevents the possible release of EtBr in vapor form.

When transporting EtBr-stained gels (for example, to the dark room), use a rigid box to contain the gels. Designate a box specifically for this purpose. You must avoid contamination of door handles with EtBr by using an ungloved hand to open doors.

How to Protect Yourself When Viewing Electrophoretic Gels

Short wave ultraviolet (UV) radiation will harm your eyes and skin. Ordinary prescription eyeglasses do not protect your eyes from this intense UV. When using ultraviolet light to visualize EtBr, you must wear UV-blocking eyewear, full-face shield, long-sleeve protective clothing, and gloves for protection.
DISPOSAL

Disposal of EtBr solutions into the sanitary sewer or sink drain is not permitted. EtBr gels and unwanted solid EtBr must be disposed through Environmental Health and Safety Office (EH&S). Liquids or working solutions may also be disposed through EH&S or rendered non-toxic by the user. Gels may be accumulated in plastic jars or buckets which are lined with an appropriate polythene bags and have lids. These containers must be clearly marked with words "Hazardous Chemical Waste" and "EtBr, Mutagenic". Full bags should be sealed, removed from the container and placed inside a second robust polythene bag for disposal. Do not mix other waste with gels such as plastic wrap, gloves, paper towels, sharps, or other contaminated items. Any additional materials in the gels must be removed by waste handling personnel and may result in injury. These solid materials must be packaged separately and labeled as chemically contaminated items. Sharps must be in a puncture resistant container and labeled appropriately. Label all waste with a Hazardous Chemical Waste tag and refer to UT Arlington Standard Operating Procedure for Hazardous Waste Disposal for both solutions, gels, and other items.

DECONTAMINATION

For small spills of weak concentration (e.g. up to 10 ml of 10mg/ml EtBr) after mopping up the spill with paper towels, wash the area down with a 50:50 mixture of isopropyl alcohol (IPA) and water. Dispose of all contaminated solids as hazardous chemical waste.

If you spill a large quantity of EtBr, immediately decontaminate the area following the procedure below:

Prepare this decontamination solution just prior to use:
- 4.2 g sodium nitrite (NaNO₂, CAS No. 7362-00-0)
- 20 mL 50% hypophosphorous acid (H₃PO₂, CAS No. 6303-21-5)
- 300 mL water

Wearing full Personal Protective Equipment (eye protection, gloves and apron/smock/lab coat) wash the area with a paper towel soaked in decontamination solution. Rinse the area five times with paper towels soaked in tap water, using a fresh towel each time.
1. Using a UV light and wearing eye protection check the area to ensure that you have removed all EtBr. Repeat decontamination procedure as necessary. If the acid could damage the contaminated surface, use a few additional rinses with paper towels soaked in tap water.
2. Soak all the towels in decontamination solution for one hour. Then remove the towels, gently wring out any excess solution back into the decontamination container, and dispose of the towels as dry hazardous waste in a doubled bag along with the contaminated gloves.
3. Include the decontamination solution and all solids in your hazardous waste pickup.
4. Inform your PI.

Note: Do not use bleach to cleanup EtBr spills. The combination may be explosive.

ALTERNATIVES TO EtBr

Consider switching to less-toxic alternatives (for example, SYBR Safe™ DNA gel stain, GelRed™, GelGreen™, MegaFluor™) to EtBr to reduce potential hazardous exposures in the laboratory. Disposal of most EtBr alternatives must be managed in a manner similar to that described above for EtBr.

REFERENCES


Revised 4/2011
INTRODUCTION

Autoclave Action

Sterilization is defined as the complete destruction of all forms of microbial life, including bacterial spores. The meaning of this word is absolute; there is no such thing as "partial sterilization." Something is either sterile or non-sterile. Sterilization can be accomplished by either physical or chemical means. The principal physical means is autoclaving, the most effective and most reliable means of sterilization.

An autoclave is a common piece of lab equipment which operates by using steam under pressure as the sterilizing agent. High pressures enable steam to reach high temperatures, thus increasing its heat content and killing power. Moist heat kills microorganisms by causing coagulation of essential proteins. Death rate is directly proportional to the concentration of microorganisms at any given time. The time required to kill a known population of microorganisms in a specific suspension at a particular temperature is referred to as thermal death time (TDT). Increasing the temperature decreases TDT, and lowering the temperature increases TDT. Environmental conditions also influence TDT. TDT decreases with pronounced acidic or basic pH. Fats and oils slow heat penetration and increase TDT. Processes conducted at high temperatures for short periods of time are preferred over lower temperatures for longer times.

Autoclave temperature, pressure, and time settings are very important to ensure adequate decontamination of biohazardous waste and thus render infectious material safe. Higher temperatures ensure more rapid killing. The most standard temperature/pressure combination employed is 121°C/15 psig (pound-force per square inch gauge). Longer times are needed for larger loads, large volumes of liquid, and denser materials. When proper conditions and time are employed, no living organisms will survive the autoclave kill cycle. Autoclaves may have settings for "LIQUIDS" to be used for liquid materials. "LIQUID" settings run for longer periods at lower temperatures to minimize liquid evaporation and spills. For solid materials, the "DRY GOODS WITH VACUUM" should be used for infectious waste as it is the most effective at moving steam and heat into the deepest parts of large bags producing the best conditions for killing persistent organisms. Exhaust settings should also be appropriate for the type of waste being autoclaved. FAST exhaust should be used for solid items and SLOW exhaust should be used for liquids.
IS YOUR AUTOCLAVE WORKING PROPERLY?

Biological waste is an important occupational hazard for people who work with the waste products of research and teaching laboratories. Biological (or special) waste has been identified by the Texas Board of Health as waste which requires special handling to protect human health or the environment. Biological waste is regulated by the Texas Commission on Environmental Quality (TCEQ) (1) and the Texas Department of State Health Services (TDSHS) (2). It is very important to be able to assure that viable biohazardous organisms are not sent to the landfill. If adequate steam does not contact with biohazardous materials, microorganisms can survive a trip through the autoclave. Autoclave tape is not a reliable means to determine if the time, temperature, and pressure combination of the process was adequate to penetrate and kill microorganisms contained within the load.

Autoclaves used for kill loads are tested periodically by Environmental Health and Safety Office (EH&S) for killing effectiveness through the use of biological indicators. Spore ampoules are self-contained biological indicators and they are intended for use in the monitoring of saturated steam sterilization cycles at 121°C. Commercially available Geobacillus stearothermophilus spore ampoules have average spore populations of $10^4$ to $10^6$ organisms. Spores are suspended in growth medium containing bromocresol purple to function as a pH indicator. The acid production associated with growth causes a change in color from purple to or toward yellow.

Spore ampoules:
- should be stored in a refrigerator at 2-8°C
- should not be frozen
- should not be used if damaged
- should not be used after expiration date
- should be handled with care since they contain live cultures
- are not intended for flash sterilization processes

In addition to this periodic autoclave testing, autoclaves go through maintenance every four to six months as per the service contracts to verify that they are functioning correctly. With the increasing concern for safe handling and disposal of infectious wastes, we must take the time and make the effort to ensure that our autoclaves are working properly. Please contact the EH&S Biological Safety Specialist, at 817-272-2185 with any questions or comments concerning autoclave testing or the Biology Departments Manager of the Genomics Core Facility, at 817-272-0090 with questions concerning maintenance of Life Science Building autoclaves.
AUTOCLAVE PERFORMANCE CHECKS

The time and temperature used for each type of waste in the laboratory should be validated using biological indicators to ensure effective sterilization. Autoclaves used for kill loads are tested quarterly by EH&S. If test results indicate that the autoclave is not sterilizing properly, the autoclave should not be used for waste until it has been repaired. A notice shall be placed on the autoclave indicating that it is not to be used until the problem is diagnosed and corrected. The first load run in the autoclave should be tested with biological indicators to insure proper functioning of the autoclave.

AUTOCLAVE WASTE DECONTAMINATION CYCLE TESTING & VERIFICATION

**Exposure:** Place one or more biological indicators in the most difficult location to sterilize, usually in the middle of the waste bag or material to be autoclaved or suspended in a volume of liquid. Autoclave tape can also be used to secure the test ampoule(s) to the outside of autoclave bag.

**Solid waste.** Do not overfill waste bags or the autoclave. This will interfere with steam penetration. Add about 50-100 ml (~1/4 to 1/2 cup) of water to each bag of solid waste to facilitate steam penetration in the bag. If there is naturally-occurring water in the load, adding additional water is not necessary. Keep the waste bags slightly open to allow for steam penetration. Bags are placed into stainless steel or polypropylene trays prior to autoclaving.

**Liquid waste.** Liquids should be placed in borosilicate (Kimax or Pyrex) or polypropylene containers for autoclaving. The containers should not be filled to more than 75% capacity. The caps or stoppers on the containers should be loosened. **Never autoclave sealed containers of liquid. This could result in an explosion of superheated liquid.** Liquid containers should be placed in a stainless steel or polypropylene tray with ¼ to ½ inch of water in the bottom of the tray so that the bottles will heat more evenly. The tray should be placed on a shelf in the autoclave and not on the bottom of the chamber.

Autoclave the waste following normal procedures using the appropriate cycle/settings. Allow time for the autoclave to cool down and for pressure to return to atmospheric. Wear heat-resistant gloves when first opening the door after a run.

Once the cycle is complete, remove autoclave tray and bag from autoclave using insulated gloves or heat resistant mitts, a rubber apron in addition to rubber sleeve protectors, and a face shield, and let contents cool. Wait no less than ten minutes when you are autoclaving liquids before removing the items. **Caution:** After sterilization, handle ampoules with care. Contents of the ampoule are hot and under pressure. Failure to allow sufficient cooling time (10-15 minutes) may result in bursting of the ampoule! Remove the indicator(s) from the waste bag(s) wearing appropriate protective equipment.

**Incubation:** Place the processed biological indicator ampoule(s) in a vertical position in an incubator at 55-60°C. Mark a control indicator ampoule as such and incubate along with processed ampoules to ensure/check spore viability. Incubate for 48 hours.
**Monitoring:** Examine the biological indicator ampoules daily during incubation. Check for signs of growth at regular intervals during the incubation period (24 and 48 hours). Record observations. All positive ampoules should be recorded and then disposed of immediately (see info of ampoule disposal below).

**Interpretation:**

**Control:** The control ampoule should exhibit a color change to or toward yellow and/or turbidity. If the control ampoule shows no signs of growth, consider the test invalid.

**Test:** A failed sterilization cycle is indicated by turbidity and/or a change in color to or toward yellow. A test ampoule that retains its purple color indicates an adequate sterilization cycle. If there are signs of growth on the indicator placed in the waste, the waste was not sterilized properly. The time, temperature, and autoclave procedures should be re-evaluated. If an autoclave problem is suspected; contact the Manager of the Genomics Core Facility at 817-272-0090 immediately.

A log of each test is maintained by EH&S, which includes the type of indicator used, date, time, and result of the test.

**Disposal:** All positive and expired units should be incinerated or sterilized prior to disposal.

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**REFERENCES**

1. The Texas Commission on Environmental Quality (TCEQ) rules: 30 Texas Administrative Code (TAC), Chapter 330.

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A test ampoule retaining its purple color indicates an adequate sterilization cycle.

A failed sterilization cycle is indicated by turbidity and/or a change in color to or toward yellow.

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INTRODUCTION

Autoclaves are sterilizers using high pressure and high temperature steam to sterilize media, glassware, instruments, waste, etc. To accomplish the desired goal and to protect the user and the environment from hazardous materials, the autoclave must be used correctly. Additionally, wastes must be managed in compliance with state and local regulations. The physical hazards that are involved with steam autoclaves are heat, steam, and pressure. The biological hazards involve potential exposure to viable human pathogens.

Due to the high heat and pressure created in autoclaves during operation, proper loading, use, and unloading procedures must be followed to prevent burns and other accidents. Burns can result from physical contact with the structure of the autoclave and steam burns can occur from contact with steam leaving the apparatus. Burns can also result from careless handling of vessels containing hot liquids. Explosive breakage of glass vessels during opening and unloading as a result of temperature stresses can lead to mechanical injury, cuts, and burns. Autoclave performance for the purpose of sterilization is dependent on proper use. This SOP provides guidance related to prevention of injuries as well as effective sterilization.

GENERAL PRECAUTIONS

It is the supervisor’s responsibility to ensure his/her employees are trained before operating any autoclave unit and that procedural and instructional documents are followed. Personnel who use an autoclave must be trained to understand proper packaging, loading, labeling, and operation procedures.

All potentially infectious materials must be autoclaved before being washed and stored or disposed.

Biohazardous materials must be labeled as such and must be sterilized by the end of each work day, or must be secured appropriately. Biohazardous materials should not be left in an autoclave overnight in anticipation of autoclaving the next day.

For the autoclave process to be effective in achieving sterilization, sufficient temperature, time and direct steam contact are essential. Air must be completely removed from the sterilizer chamber and from the materials to allow proper steam penetration. Factors that affect air removal include type and quantity of material to be autoclaved, packaging, load density and configuration, and container type, size, and shape.

ASSOCIATED RISKS
The potential safety risks for the autoclave operators are:

- Heat burns – from hot materials and autoclave chamber walls and door
- Steam burns – from residual steam coming out from autoclave and materials on completion of cycle
- Hot fluid scalds – from boiling liquids and spillage in autoclave
- Hand and arm injuries when closing the door
- Body injury if there is an explosion

EQUIPMENTS TO PROTECT AGAINST SCALDS AND BURNS

Personal protective clothing and equipment must be worn when loading and unloading the autoclave:

- Heat-insulating gloves protect hands and forearms.
- Face shields protect face and neck.
- Splash apron protect chest and legs.
- Closed-toed footwear protects feet.

PREPARATION FOR AUTOCLAVING

- Ensure that the material is able to be autoclaved. Oils, waxes, some plastics, flammable materials, radioactive materials, and samples containing solvents or substances may emit toxic fumes and should not be autoclaved.
- Glassware should be heat-resistant borosilicate (Pyrex or Kimax) and inspected for cracks prior to autoclaving.
- Plastics should be heat-resistant, for example, polycarbonate (PC), PTFE ("Teflon") and most polypropylene (PP) items.
- Prepare and package material suitably:
  - Loose dry materials should be wrapped or bagged in steam-penetrable paper or loosely covered with aluminum foil. Wrapping too tightly will impede steam penetration, decreasing efficiency of the process.
  - Containers of liquid should be a maximum volume of 2/3rds filled.
  - All containers should be covered by a loosened lid or steam-penetrable bung to prevent pressure buildup and avoid having bottles shatter during pressurization.
  - Use plain, unmarked containers for items that are not hazardous.
  - Items or baskets should be tagged with autoclave temperature tape to verify adequate thermal treatment.
  - Place items in containers to secure and contain spills. Place containers of liquid, bags of agar plates, or other materials that may boil over or leak inside a secondary pan (could be autoclavable plastic or stainless steel container) in the autoclave. The pan must be large enough to contain a total spill of the contents. Open, shallow metal pans are more effective in conducting heat and allowing air removal than tall, plastic tubs.
• Adding some water to the secondary pan will help to heat items more evenly.

LOADING THE AUTOCLAVE

• Make sure the drain strainer in the bottom of the autoclave is clean before loading the autoclave.
• Use a cart to transfer items to be autoclaved. To avoid back injuries, push the cart up to the autoclave door and gently slide the load into the autoclave.

• Never place autoclave bags or glassware in direct contact with the bottom of the autoclave. Place the secondary pan containing the items to be sterilized on the shelf or rack of the autoclave.
• Do not overload the autoclave. It is important to leave sufficient room for thorough steam circulation.
• Do not mix loads of liquids with solids.
• Firmly lock autoclave door prior to starting the run to prevent sudden release of high-pressure steam.
• Make sure that you have selected the correct cycle before starting the autoclave (see below).

OPERATING PARAMETERS

The parameters for the sterilization cycle will depend upon the amount and type of material. Usually 121°C at 15 psig (pound-force per square inch gauge) for a minimum of 30 minutes is recommended. However, the temperature and cycle time can be increased taking into consideration the size and type of load. Autoclave manufacturers generally provide several preset cycle options which will vary in the preset sterilization temperature, sterilization time, and dry time.

• Gravity cycle – air removal from the autoclave chamber prior to the sterilization part is achieved by gravity air purge. A gravity cycle is appropriate for loads where air removal from porous materials or penetration of steam into wrapped/packaged items is not required.
• Vacuum cycle – air removal from the autoclave chamber prior to the sterilization part is achieved by pulsing between pressure and vacuum. Vacuum cycle is suitable for wrapped or difficult to penetrate items.
• Liquids cycle – gravity air purge removes air from the chamber as in gravity cycle. Pulling a deep vacuum is not done since liquids to be autoclaved would be drawn out of their vessels.

The exact operating procedure for each model of autoclave will differ. The user should develop a standard operating procedure to describe proper steps to operate the autoclave.
UNLOADING THE AUTOCLAVE

After the run is completed, check the pressure gauge to ensure that the pressure in the chamber is “0”. If pressure is not released, do not open the door. Inform your PI / supervisor about the malfunction.

- Before opening the door, put on your eye protection and heat-resistant gloves or mitts. Be sure to wear closed-toed shoes (hot condensate may drip from the door). Rubber aprons in addition to rubber sleeve protectors are advisable.
- Carefully crack door open to release residual steam and allow pressure within liquids and containers to normalize. Wait a full five minutes if the autoclave load contains only dry glassware, and no less than ten minutes when you are autoclaving liquids before removing the items.
- Use caution when removing liquids, molten agar, etc. Liquids, especially large volumes, may continue boiling for some time after autoclaving. Do not agitate containers of super-heated liquid or remove caps before unloading to avoid getting splashed with scalding liquid.
- Slide a cart to the opening of the autoclave and pull the autoclave secondary container onto the cart for transport. Place the cart in a low traffic area while additional cooling occurs.
- Let glassware cool for 15 minutes and liquid loads for a full hour before touching the items with ungloved hands. Note that hot glass looks like cool glass.

**NOTE:** If a faulty condition exists (e.g., sterilizer did not finish the cycle, or water leaks out when the door is unlocked), contact a service technician.

AUTOCLAVING BIOHAZARDOUS WASTE MATERIALS

Use heat resistant autoclavable bags labeled “biohazard” (usually red or orange) for waste materials that contain or may be contaminated with potentially infectious agents.

- Biohazardous waste bags should be stored in rigid leak-proof secondary containment pans.
- Waste should be stored inside the autoclave room and not in the hallways.
- Do not double bag waste or tightly seal bags as this will impede steam penetration.
- Avoid compressing bags. This may create aerosols.
- It is advisable to add some water to bags of solid wastes (the water will vaporize into steam that will drive out residual air once sterilization temperature has been reached inside the bag).
- Do not put sharp objects such as broken glassware into an autoclave bag.
- When using an autoclave bag with a “biohazard” symbol on it, label these bags with commercially available autoclave temperature tape that changes color, e.g., visible black stripes appear or the word “AUTOCLAVED” appears upon adequate
thermal treatment. Autoclave temperature tape only tells that desired temperature was reached not time or pressure). Apply this tape across the “biohazard” symbol on the bag before autoclaving. Do not throw away any biohazard bags without covering all biohazard symbols.

- Use secondary containment pan under the bag to catch any leaks that may occur during autoclaving.
- Autoclave 50 to 60 minutes, at temperature and pressure of 121°C (250°F) and 15 psig.
- When cycle is finished, inspect autoclave temperature tape, and visually check bags to ensure autoclave was working correctly.
- Bags should be left to cool for several minutes before removing from autoclave. Once cool, securely close biohazard bag with tape or tie wrap.
- Attach a label to autoclaved waste bag that states, “Treated in accordance with the provisions of 25 TAC § 1.136(a)” and place the bag inside another opaque bag (black, green, etc.) to be placed in the regular trash.

- Parameter monitoring (pressure, time, and temperature) is important to ensure efficacy of the autoclave.
- Do not pour melted agar in a sewer as it will congeal and clog the plumbing.
- Biohazardous waste should not be left for “someone else” to autoclave.

RECORDKEEPING FOR TREATMENT OF BIOHAZARDOUS WASTE

- Document the treatment of each load of biohazardous waste on the Autoclave Waste Treatment Record provided by EH&S which lists the date of treatment, the amount of waste treated, the method/conditions of treatment, and the printed name.
- Keep charts or printout strips (if autoclave is equipped with these types of documenting options) with the log sheets as documentation of the autoclave operation.

REPAIRS / MAINTENANCE

- No person shall operate an autoclave unless it has been inspected by a qualified inspector and a certificate of inspection has been issued. A current inspection certificate must be posted near the autoclave.
- Users are not to make repairs. Autoclaves shall be maintained and repaired by qualified persons.
- If the autoclave does not operate exactly as expected, a notice shall be placed on the autoclave indicating that it is not to be used until the problem is diagnosed and corrected.
- Record the problem in the autoclave log book.
- When maintenance work or repairs are needed, the user must provide a safe work environment for the service technician. Remove all items from the sterilizer
chamber, clean any spills or leaks inside the chamber, remove untreated biohazardous materials from the vicinity, etc.

INCIDENT RESPONSE
- If any injury occurs seek first aid or, if necessary, seek medical assistance by dialing UT Arlington Police Dispatch at 817-272-3003.
- If clothing is soaked in hot water/steam, remove clothing and cool the injured part in cool water.
- Place a notice on the autoclave indicating that it is not to be used until the cause of the incident is determined, procedures enacted to prevent future incidents, and the autoclave is deemed safe for operation.
- A list of people trained to provide first aid will be posted in the autoclave room.
- All other non-emergency incidents are to be reported to EH&S at 817-272-2185.

SPILL CLEAN-UP
- Spills may occur from a boil-over or breakage of containers.
- No operation of the autoclave is allowed until the spill is cleaned up.
- The operator is responsible for clean-up of spills. Contain the spilled material using materials from the spill kit to absorb or contain the spill.
- Wait until the autoclave and materials have cooled to room temperature before starting the cleanup inside the autoclave.
- Review the Material Safety Data Sheets (MSDS), if appropriate, to determine the protective equipment, spill cleanup, and disposal protocols that are necessary.
- Clean the equipment and work area in order to collect and remove all spilled materials. Dispose of the waste following the protocol appropriate for the material. If materials have been intermingled, follow the cleanup and disposal protocol for the most hazardous component of the mixture.
- Cracked glassware must be disposed of properly in a broken glass disposal container provided by EH&S.
- Record the spill and cleanup procedure in the autoclave log book.

AUTOCLAVE PERFORMANCE CHECKS

EH&S will check the autoclave performance for waste treatment. The efficacy is monitored with biological indicators (ampoule of Geobacillus stearothermophilus spores) at an appropriate frequency to ensure that the sterilization parameters are effective in treating biohazardous waste. Refer to the Performance Verification of Steam Autoclave Kill Cycle SOP for additional information.

The documentation of the waste sterilization treatment / results of any verification tests using biological indicators are kept in EH&S.
REFERENCES


Should you have any questions regarding autoclaving operations and procedures, please do not hesitate to contact Merja Karwoski at the Environmental Health and Safety Office, 817-272-0068.

Revised 4/2011
STANDARD OPERATING PROCEDURE
UNIVERSAL PRECAUTIONS

INTRODUCTION

The control of potential biological hazards in biomedical and clinical laboratories is provided by the use of standard work practices, commonly referred to as Universal Precautions. The following recommendations have been developed for use in health care settings as well. These practices reduce the possibility of transmission of bloodborne pathogens such as Human Immunodeficiency Virus (HIV) and Hepatitis B Virus (HBV). Universal Precautions apply to human blood and to other body fluids containing visible blood. Universal Precautions also apply to semen and vaginal secretions; tissues; and to cerebrospinal, synovial, pleural, peritoneal, pericardial, and amniotic fluids.

The use of universal precautions when handling human blood, human tissue, and body fluids does not affect other types of infection control practices such as the identification and handling of infectious laboratory specimens, waste, disinfection, sterilization, decontamination, or laundry procedures and practices.

UNIVERSAL PRECAUTIONS FOR HEALTH CARE WORKERS

- Use appropriate barrier precautions to prevent skin and mucous membrane exposure when you anticipate contact with human blood or other body fluids. Wear gloves for touching blood and body fluids, mucous membranes, or non-intact skin of all patients, for handling items or surfaces soiled with blood or body fluids, and for performing venipuncture and other vascular access procedures. Change your gloves after contact with each patient. Wear masks and protective eyewear or face shields during procedures that are likely to generate droplets of blood or other body fluids to prevent exposure of mucous membranes of the mouth, nose, and eyes. Wear gowns or aprons during procedures that are likely to generate splashes of blood or other body fluids.

- Wash your hands and other skin surfaces immediately and thoroughly if contaminated with human blood or other body fluids. Wash your hands immediately after you remove your gloves using soap and warm water.

- All health-care workers should take precautions to prevent injuries caused by needles, scalpels, and other sharp instruments or devices during procedures; when cleaning used instruments; during disposal of used needles; and when handling sharp instruments after procedures. To prevent needle stick injuries, do not recap needles, purposely bend or break them by hand, remove from disposable syringes, or otherwise manipulate these sharps by hand. After you use sharps, place them in puncture-resistant containers for disposal; locate the puncture-resistant containers as close as practical to your work area. The containers must be marked with biohazard sign.

- Pregnant health care workers are not known to be at greater risk of contracting HIV infection than health care workers who are not pregnant; however, if a health
care worker develops HIV infection during pregnancy, the infant is at risk of infection resulting from perinatal transmission. Because of this risk, pregnant health care workers should be especially familiar with and strictly adhere to precautions to minimize the risk of HIV transmission.

PRECAUTIONS FOR LABORATORY PERSONNEL

To supplement the Universal Precautions listed above the following precautions are recommended:

- All specimens of human blood and body fluids should be put in a well-constructed container with a secure lid to prevent leaking during transport.
- All persons processing human blood and body-fluid specimens, for example, removing tops from vacuum tubes, must wear gloves. Wear masks and protective eyewear if you anticipate mucous membrane contact with blood or body fluids. Change your gloves and wash your hands after completion of specimen processing.
- For routine procedures, such as histologic and pathologic studies or microbiological culturing, a biological safety cabinet (BSC) is not necessary. However, use a BSC whenever you conduct procedures that have a high potential for generating droplets. These include activities such as blending, sonicating, and vigorous mixing.
- Use mechanical pipetting devices for manipulating all liquids in the laboratory. Do not mouth-pipet!
- Limit your use of needles and syringes to situations in which there is no alternative, and follow the recommendations for preventing injuries with needles outlined earlier in this document.
- Decontaminate laboratory work surfaces with an appropriate chemical germicide after a spill of human blood or other body fluids and when you complete work activities.
- Decontaminate materials used in the laboratory before reprocessing or place them in bags or other containers with biohazard signs and dispose of according to UT Arlington procedures.
- Decontaminate equipment that has become contaminated with human blood or other body fluids and clean it before it is repaired in the laboratory or transported to the manufacturer.
- All laboratory personnel should remove protective clothing and wash their hands with soap and warm water after completing laboratory activities and before leaving the laboratory.

REFERENCES

STANDARD OPERATING PROCEDURE
USING SYRINGES AND SHARPS IN THE
(BIO)CHEMICAL LABORATORY

INTRODUCTION

Syringes are used in research laboratories for multiple tasks, including injection of gases or liquids into chromatographs, chemical apparatus, or animals. Syringes can range from precision micro-syringes to inexpensive disposable units. Needle stick injuries remain a significant hazard during syringe use, but they are not the subject of this SOP. Refer to UT Arlington’s Universal Precautions SOP which addresses precautions that should be taken to prevent injuries caused by sharps.

HAZARDS

Syringe spray-back accidents typically occur when the syringe or injection needle becomes plugged. If the syringe becomes plugged, do not push the plunger harder. High pressure inside the syringe can cause the plunger seal to fail or the barrel to crack spraying out liquid.

Non-syringe hazards include cuts, abrasions, and scratches.

HANDLING OF SYRINGES

The following steps are recommended for safe syringe use.

- Use only new disposable syringes or decontaminated reusable (such as Hamilton) syringes.
- Examine all syringes for evidence of physical damage before use.
- Check the plunger for ease of motion before drawing up liquids or gases.
- Check again for free plunger movement after installing needles or tubing.
- Remove syringes with frozen plungers or plugged needles from service.
- Clean reusable syringes after each use following the manufacturer’s instructions. Usually this means removing the plunger and rinsing the barrel with an appropriate solvent, then expelling the solvent through the needle with the plunger. Use a squeeze bottle to force cleaning liquid through the syringe.
- Avoid using detergents when cleaning syringes since removing trapped bubbles is difficult.
- Always wear eye protection or a face shield when cleaning syringes and handling chemicals in a laboratory.
- For stubborn stains or contamination, ultrasonic cleaning in an appropriate solution may be effective.
- After cleaning, the syringe plunger should be removed for drying and all seals checked. Dry syringe bodies using anhydrous, uncontaminated, compressed air. Air-drying is also appropriate.
- Reassemble the reusable syringe and plunger for storage.
Avoid using lubricants on plungers unless required by the manufacturer. Plugged needles usually occur from coring rubber septa. You can usually clear these with fine wires that come with the needle. If not, replace the needle.

Some syringes are temperature-sensitive, so avoid rapid heating or cooling. Check with the manufacturer for maximum and minimum use temperatures.

Take steps to secure the plunger when drawing a sample or injecting material into a high pressure system, thereby preventing plunger blowout and chemical release.

Disposable nitrile or exam gloves will not protect you from needle stick injuries and cuts. Leather gloves do offer protection.

NON-SYRINGE SHARPS

The most common non-syringe sharps are razor blades and scalpels. Always store these in their protective sleeves to avoid mishandling.

If you are working with non-syringe sharps, protect yourself from cuts by wearing leather gloves. Of course, in this case you sacrifice dexterity for safety.

FIRST AID

Needle stick injuries: Follow the instructions in the UT Arlington Blood and Body Fluid Exposure guidelines if a potential exposure incident to Human blood/body fluids or contaminated needle stick has occurred.

Cuts: If the cut is small, wash it thoroughly with soap and water. Dry and cover with a band-aid. If the cut is large or you cannot stop the bleeding, seek medical attention.

DISPOSAL OF SHARPS

To avoid accidental needle sticks and cuts, place disposable sharps directly into a sharps container. Do not recap, bend, break, clip, or remove needles from any syringes.

Do not overfill sharps containers. They should not be more than ¾ full.

Do not force anything into a sharps container. If it is ¾ full, start a new one.

Never put your hands in a used sharps container.

For chemical sharps: These sharps have no infectious agents or blood contaminating them. Dispose of disposable syringes and sharps in a sharps container. Do not combine them with the regular trash. Include the ¾ full sharps container with your regular hazardous waste pickup.

For biological sharps: Biological sharps may be contaminated with human blood or
microbes. Do not attempt to decontaminate sharps for any biohazard. Dispose of your contaminated sharps and syringes in a biohazard sharps container. Make sure the container is labeled with a biohazard symbol. Do not dispose of these containers with the regular trash or incinerate them. Use this form http://www.uta.edu/policy/forms/ehs/8-28.pdf for biological sharps pickup and disposal.

REFERENCES


Revised 4/2011
SAFE OPERATING PROCEDURE
CARE OF SCIENTIFIC GLASSWARE

INTRODUCTION

Glassware may seem like an unimportant and mundane topic, but using it and caring for it properly can make the difference between experimental success and failure. Glassware can also be expensive to replace routinely, so handle it with care and it will reward you with a long and useful lab life.

GENERAL HANDLING

- Always inspect glassware before use for chips, cracks, or scratches. Discard defective glassware (and used Pasteur pipets) in a box intended for broken glass, not in the regular trash. If the glassware is particularly expensive or custom-made, you can repair it by fire-polishing if you have properly trained (below.)
- Never allow glassware prolonged contact with metal or grit. Use plastic spatulas, stirring rods, and rubber policemen.
- Regrease glass stoppers and stopcocks frequently. (Do not grease Teflon stopcocks.) This will prevent sticking and breakage.
- If you need to heat glassware or quartzware, you must first triple-rinse it in deionized or distilled water after cleaning and dry it thoroughly. This will ensure that you do not permanently burn contaminates onto the glassware. When handling quartz (especially cuvettes) you should always wear clean gloves to prevent oils on your hands from contaminating and causing the onset of devitrification.

GENERAL CLEANING

Clean glassware as soon as possible after use. Allowing dirty glassware to sit around just makes eventual cleaning difficult.
- Separate your glassware into those that need regular cleaning and those that require more intense cleaning.
- Disassemble your apparatus as soon as possible after you are finished with it. Remove all stopcocks and stoppers from addition funnels, separatory funnels, and the like. Ground glass stopcocks and stoppers will freeze in place if certain reactants (for example, bases) were used in them. Triple-rinse all surfaces with an appropriate alcohol followed by water to remove traces of solvents and
reaction mixtures; place the used solvents in the appropriate hazardous waste container.

- Graduated cylinders, beakers, Erlenmeyer flasks, burets, and pipets that were only used to dispense or briefly store reagents generally only need to be triple-rinsed with a compatible solvent followed by tap water and a final deionized (DI) water rinse, if desired. Air dry on a drying rack.

- Büchner funnels, etc., should be rinsed with an appropriate solvent to remove substances that are clinging to them. Follow this with tap water and DI water rinses and air dry.

- Even a task as simple as washing glassware in the sink is potentially hazardous. Splashing solvents or dirty water in the eyes is a common hazard. You must wear eye protection appropriate for the task at all times. Gloves are recommended if the glassware contained an irritant, lachrymator, or toxic material; refer to your glove compatibility chart. Some people wear yellow Playtex kitchen gloves for cleaning glassware.

- Before cleaning, be sure that any excess reagent has been disposed of properly and the vessel in which it was contained has been triple-rinsed into the waste container.

- Degrease your glassware’s ground glass joints by wiping them with a paper towel soaked in a small amount of ether, acetone, or other solvent. Wear appropriate gloves and minimize your exposure to the vapors.

- Place the glassware in a warm concentrated aqueous solution of Alconox or other detergent and let sit for several minutes.

- Be sure that your brush is in good shape before scrubbing. It should not be rusty or have matted bristles; replace it if necessary. Use the correct brush for the glassware, for example, use bottle brushes on bottles.

- Scrub. Be careful not to push too hard on the bottoms of beakers and flasks; you can easily push through the bottoms, especially on big beakers.

- Rinse thoroughly with tap water and give a final rinse with DI water. The water should sheet cleanly off the glass. If water does not sheet off the glass, and you desire the glassware to be analytically clean, first repeat the above soaking and scrubbing steps. If after a second cleaning bits of solid still adhere to the glass, or if there is clearly a greasy residue on the glass, you need more aggressive action.

- Note: if you are doing analytical work, you should triple-rinse all glassware with DI water before letting it dry. This will remove any ions or tap water impurities.

- Dry wet glassware by 1) placing it on the drying rack (or invert on a paper towel), 2) placing it in the drying oven (for items that are water-wet only, no flammable
solvents) or 3) rinsing with a solvent such as acetone, methanol, or ethanol and then gently blowing compressed air into the vessel until it is dry. The first method is preferred for drying analytically clean glassware (provided that the prongs of the drying rack are not inside the item, thus contaminating it). Volumetric glassware and cuvettes are never to be placed in drying ovens. The third method is acceptable only when the compressed air supply is known to be free of oil and other contaminants. An alternative to blowing air into the item is to use an aspirator, or house vacuum, to pull air into the item.

MODERATELY AGGRESSIVE CLEANING

Use these guidelines if general cleaning fails. These solutions are corrosive. Use proper PPE – appropriate gloves, safety glasses, and lab coat.

- If the contaminant is a metal-containing compound, soak the piece of glassware in a 6 M HCl solution. Once the solid has dissolved, copiously rinse the item with tap water, and then repeat the general cleaning steps above. This method will also remove some organic residues but not grease.
- If the contaminant is organic, submerge the item in a base bath, which is a saturated NaOH or KOH solution in ethanol, methanol, or isopropanol. Be sure the base bath is stored in an HDPE container; otherwise it will leak. Wear butyl gloves and keep ignition sources away from it. Be sure that the piece of glassware is completely filled with the solution and is sitting upright. After several minutes of soaking, carefully remove the item (it will be slippery), and rinse thoroughly. If the glassware is not clean at this point, general cleaning steps may need to be repeated or a longer soaking time in the base bath may be needed. Do not soak any glassware in base bath longer than necessary, as it can slowly dissolve a layer of glass or even permanently etch/ frost surfaces. NEVER soak the following items in a base bath for prolonged periods:
  - Glassware contaminated with metal-containing compounds
  - Glass fritted funnels
  - Cuvettes
  - Volumetric glassware (pipets, volumetric flasks)
  - Any glassware contaminated by an oxidizing agent
  - Anything that has not been washed according to the above steps first

EXTREMELY AGGRESSIVE CLEANING

Follow these steps when the moderately aggressive methods fail. Be very careful. The solutions described are very corrosive! Only use them in a fume hood and wear proper PPE.

- **Aqua regia.** This is an extremely powerful oxidizing solution prepared from 1 part concentrated HNO₃ and 3 parts concentrated HCl. Add 1 part H₂O if you will store the aqua regia to minimize the generation of Cl₂. This is the only acidic solution that will dissolve gold and will oxidize just about everything else.
Extreme caution must be used when working with aqua regia because it generates Cl₂ and NOₓ gases in addition to causing severe tissue damage. Clean the glassware before soaking in aqua regia and then rinse thoroughly with water.

- **Acidic peroxide.** This is most conveniently prepared by dissolving the commercially-available NoChromix mix in concentrated H₂SO₄ per the package directions. An alternative preparation is to prepare a solution by mixing equal proportions of concentrated H₂SO₄ and aqueous H₂O₂ solutions (remember to add the acid to the H₂O₂). A 3% H₂O₂ solution is usually sufficient, and under no circumstances should H₂O₂ solutions greater than 10% be used. The H₂O₂/H₂SO₄ solution is both a strong oxidant and a strong reductant, so care must be taken when using it. Another acidic peroxide solution for cleaning can be prepared by dissolving 36 g (NH₄)₂S₂O₈ (ammonium peroxydisulfate) in 2.2 L of 98% H₂SO₄ (can be made right in the bottle of H₂SO₄, if the bottle is loosely stoppered). The procedure for these solutions is the same as for aqua regia, as are the precautions for their use.

- **Chromic Acid.** This is a solution of CrO₃ in concentrated H₂SO₄. A premeasured mix is available under the name Chromerge which should be treated in the same way as aqua regia or acidic peroxide solutions. Because high-valent chromium is carcinogenic, teratogenic, and causes severe environmental damage, the use of chromic acid is not recommended.

**SPECIAL CASES**

- **Cuvettes.** Generally, you only need to rinse a cuvette in the appropriate solvent and wipe the outside with a Kimwipe immediately after use. If something has adhered itself to a cuvette, it is best to soak the cuvette in solvent first and gently coax the solid off the side with a cotton swab. **Never use a brush on a cuvette!** If this fails, you can use 6 M HCl. Do not use a base bath on cuvettes because it tends to etch glass surfaces. **Never put cuvettes in a drying oven;** air-dry them.

- **Fritted Funnels.** You can clean these by inverting and allowing the solvent to flow by gravity through the frit in reverse. You can also pull solvent through the frit under vacuum. You can remove stubborn material by soaking in acid, followed by copious rinsing with water under vacuum. Because the base bath solution etches glass, do not use it on fritted funnels (a brief exposure to a base bath is not usually fatal to a frit, but prolonged soaking should be avoided).

- **Protein Contamination.** You can usually remove proteins by scrubbing with detergent, but occasionally protein defies removal. In that event you can proceed to the more aggressive acidic solutions, or you can prepare a peptidase solution. The enzymatic approach is a bit slower than the forcing methods, but it is greener and gentler and so you can use it when the contaminated item is incompatible with acid.

- **Fire Polishing.** If you want to save mildly chipped glassware, you can fire-polish it. Light a Bunsen burner (be sure no flammables are nearby) and place the site of damage inside the hottest part of the flame. Allow the glass to melt enough to smooth the rough edges of the damage on all sides. When the glass has melted...
enough, remove it from the heat and allow to cool. Be careful – hot glass looks like cool glass. Turn off the burner.

For more information, see http://www.udel.edu/chem/GlassShop/GlasswareCare.htm

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STANDARD OPERATING PROCEDURE
REQUEST FOR NEW CHEMICALS TO BE ADDED TO YOUR INVENTORY

Step 1: Log into the Chemical Environmental Management System (CEMS) http://cems.uta.edu
Step 2: Sign-in by selecting your name and using your CEMS password.
Step 3: Click “Contact EH&S” at the top right corner of your screen. A new window in a message format will open.
Step 4: In the Subject line type “New Chemicals”. In the Message, please, include the name of the laboratory manager, room number, and location of the new chemicals that need to be added to your inventory.
EXAMPLE:
To: CEMS Administration
From: Elisabeth Rowlett

Subject:

Please, add new chemicals to Dr. Johnson's inventory (Bioengineering).
Find new items in ERB 180 on the workbench.

Thank you.

Message:

Step 5: Click “Send Message” on the lower left side of the screen. The message will be sent to a CEMS Administrator and your request will be completed within 2 working days.
STANDARD OPERATING PROCEDURE
REQUEST FOR WASTE REMOVAL

Step 1: Log into the Chemical Environmental Management System (CEMS) http://cem.s.uta.edu
Step 2: Sign-in by selecting your name and using your CEMS password.
Step 3: Click “request waste removal” in the section “Hazardous Waste” of the “My Responsibilities” window.

Step 4: Fill out the “Hazardous Waste Pickup Request Form” by choosing your name under “Principal Investigator” and the location of the waste under “Pick-up Location” (Department will display automatically).
List the containers with waste starting with the Tag # (Tags provided by EH&S to be attached to every container with waste).
List the chemicals of each container in the “Comments” window.
<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>other:</td>
</tr>
<tr>
<td>6</td>
<td>other:</td>
</tr>
<tr>
<td>7</td>
<td>other:</td>
</tr>
<tr>
<td>8</td>
<td>other:</td>
</tr>
<tr>
<td>9</td>
<td>other:</td>
</tr>
<tr>
<td>10</td>
<td>other:</td>
</tr>
</tbody>
</table>

**Comments**

Tag # 36723: acetone, propanol, ethanol;
Tag # 36724: chloroform, methylene chloride;
Tag # 36725: nickel sulfate;
Tag # 36726: cadmium contaminated wipes and gloves

**Step 5: Click “submit”**.
The message will be sent to a CEMS Administrator and your request will be completed within 3 working days.
SAFE OPERATING PROCEDURE
COMPRESSED GAS CYLINDERS
PRESSURIZED EQUIPMENT AND PRESSURE VESSELS

DEFINITION

A compressed gas is defined as any mixture of gases in a container with a pressure exceeding 40 psi at 70°F/21°C, 104 psi at 130°F/55°C, or any flammable liquid with an absolute vapor pressure exceeding 40 psi at 100°F/38°C.

HAZARDS

Cylinders of compressed gases can pose a chemical hazard as well as a physical hazard. 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 ½ pounds of TNT.

CONTAINERS REQUIREMENTS FOR COMPRESSED GASES

- All compressed gas cylinders or containers delivered to or shipped from the University must be marked, labeled, stored, and handled in accordance with all applicable rules and regulations, including DOT, OSHA, and NFPA standards.
- The contents of each cylinder and container must be clearly identified by tag or stamp on the cylinder.
- University faculty, staff, and students must not remove or alter any identification on a compressed gas cylinder.
- Do not purchase a larger cylinder size than necessary. Only gases in returnable containers should be selected for purchase; lecture bottles are an exception.

STORAGE OF COMPRESSED GAS CYLINDERS

- Storage areas for compressed gas cylinders must be designed to accommodate the gases used and provide adequate spacing and/or segregation in accordance with applicable building codes and regulations. Compressed gas cylinder storage areas must be segregated from exit corridors and egress paths.
- Storage areas should be designated by hazard class and marked clearly with appropriate warning signs that restrict access.
- Consideration must be given to separate storage of full and empty containers. Incompatible gases must be segregated by at least 20 feet or an appropriately rated and designed wall or barrier.
- The cylinder storage area should be dry, well-ventilated, and be of fire-resistant construction when necessitated by the gas in storage.
- Compressed gas cylinders must not be stored near sources of heat and ignition or near corrosive chemicals or fumes.
• Compressed gas cylinders must not be stored near unprotected platform edges or in any location where heavy moving objects may strike or fall on them.

• All compressed gas cylinders (whether empty or full) must be secured in an upright position using an approved chain, strap, or floor device to prevent falling. There should be no more than five cylinders per securing device.

• Approved chains or straps should be secured around the top 1/3 of the cylinders. Securing devices should never be around the neck, regulator, or bottom 1/3 of the cylinder.

• All compressed gas cylinders must be fitted with a protective valve cap or guard while in storage.

• If use of small non-refillable cylinders (lecture bottles) is unavoidable, they should be secured in a device, cage, or box designed for cylinders 18 inches or smaller.

• Toxic gases (such as F₂, CO, and H₂S) should be stored and used in a chemical fume hood. If this is not feasible, the area of use must be equipped with a detection system specific to the toxic gas or inhalation hazard. Refer to UTA Safe Operating Procedure for Toxic Gases.

• 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.

• Position all cylinders so that the main valve is always accessible.

SAFE HANDLING OF COMPRESSED GAS CYLINDERS

1. Persons handling compressed gas cylinders must:
   • Be familiar with the hazards of the compressed gas.
   • Always use a cylinder cart or other transport device to move cylinders in a secured fashion. Never drag a cylinder by valves or caps or roll a cylinder in a horizontal position. Compressed gas cylinders should be transported with the cylinder cap securely fastened.
   • Never use a compressed gas cylinder as a support or door stop.
   • Keep caps on cylinders unless connected to dispensing equipment systems.
   • Never expose cylinders to temperature extremes, direct flame, or heat.

2. Never use a gas cylinder that cannot be positively identified. Color-coding is not a reliable way of identifying a gas cylinder because the colors can vary from supplier to supplier.

3. Empty compressed gas cylinders must be:
   • Closed.
   • Secured at all times.
   • Labeled to indicate “empty.”

4. Regulators control the rate at which gas is delivered from the cylinder so the gas may be used safely. Never discharge a gas without the use of a regulator. Compressed gas piping, regulators, and flow control equipment must be:
   • Compatible with the chemical and physical properties of gas.
   • Capable of withstanding gas supply pressures.
installed and operated by trained and qualified persons familiar with the specific hazards of the gases in use.

- Grounded to minimize sparks due to static discharge when using flammable gas.
- Provided with a means for safely purging the system and devices to prevent backflow of gases or liquids into the gas storage cylinders when using hygroscopic corrosive gases, such as anhydrous HCl.
- Leak-tested upon installation and monthly thereafter around valve gland, regulator connections, and fittings.

5. 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 for which it was not designed. Regulators are designed to fit only specific cylinder valves to avoid improper use.

6. Inspect regulators, pressure relief devices, valves, cylinder connections, and hose lines frequently for damage.

7. Do not use oil or grease on any cylinder component of an oxidizing gas because a fire or explosion can result.

8. Never transfer gases from one cylinder to another.
   - The gas may be incompatible with the residual gas remaining in the cylinder.
   - The gas may be incompatible with the material of which the cylinder is made.

   - Leave approximately 25 psi of pressure.
   - This will prevent any residual gas in the cylinder from becoming contaminated.

**EMERGENCY PROCEDURES FOR COMPRESSED GAS CYLINDERS**

1. Personnel should be aware of common emergency situations involving compressed gases and their associated hazards, such as:
   - An unsecured cylinder may tip and become damaged in a manner that the release of internal pressure can cause the cylinder to become a dangerous high-speed projectile.
   - A fire threatening the cylinder can cause a rupture or explosion.
   - A flammable gas leak can cause a buildup of explosive gases.
   - A leak can cause high concentrations of gas that exceed safe breathing levels or an inert gas leak can cause an oxygen-deficient atmosphere that is a threat to life safety.
   - An unplanned chemical reaction may cause a cylinder rupture or explosion of apparatus.

2. Fires involving compressed gas cylinders should be handled with extreme caution.
   - Do not take unnecessary risks to save equipment-- evacuate the area.
   - Only when safe to do so, release pressure in affected pipelines and shut off equipment prior to evacuation.
   - If safe to do so, shut off gas supply to ignited flammable gas leaks or allow fire to burn out while controlling the ignition of surrounding materials.
Never attempt to extinguish a flammable gas leak without stopping the flow of gas.

Any compressed gas cylinder involved in a fire must be taken out of service and returned to the supplier.

3. Some common leak points and their potential repairs:

- Valve outlet/regulator connection: dirt in connection, damaged connector or washer.
- Valve stem spindle: tighten adjustable gland nut ¼ turn with valve stem loosened or tighten lock nut if present on gland fitting.
- Cylinder valve to cylinder joint: cannot be repaired in the field, remove from service. Label and return to supplier.
- Valve closure: tighten valve or if defective, set aside, label and return to supplier.
- Leaking gas control equipment/pipelines: isolate gas supply, release pressure, and purge equipment of hazardous gas before attempting repair.
- Use only wrenches or other tools supplied by the cylinder manufacturer to open a valve.
- Open cylinder valves slowly.

DISPOSAL OF COMPRESSED GAS CYLINDERS

- Contact your cylinder vendor to return damaged, excess, or unknown cylinders. All users will be responsible for returning all cylinders to the manufacturer/distributor.
- 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.

PRESSURIZED EQUIPMENT AND PRESSURE VESSELS

Common examples of pressure vessels or pressurized equipment are steam boilers, autoclaves, compressor tanks, pressurized research equipment, reactors, and calorimeters. University employees should follow these basic safety guidelines when working with pressure vessels or pressurized equipment:

- Pressurized equipment used at pressures at or above 103 kPa gauge (15 psig) must be designed and constructed by qualified individuals for use at the expected temperature, pressure, and other operating conditions.
- Pressure equipment must be fitted with a pressure relief device, such as a rupture disc, relief valve, or blow down valve. This pressure relief device must be vented to a safe location.
- Laboratory pressure vessels or equipment operated at pressures above 103 kPa gauge (15 psig) must be operated and maintained according to manufacturer's instructions, the design limitations of the equipment, and applicable codes and regulations.
- This equipment must be inspected at least annually.
5. Any significant change in the condition of the equipment, such as corrosion, cracks, distortion, scale formation, chemical attack, weakening of the closure, or the inability of the equipment to maintain pressure, should be documented.

Equipment that exhibits any of the above changes must be removed from service immediately and shall not be returned to service until repaired and approved by a qualified person.
SAFE OPERATING PROCEDURE
CRYOGENIC FLUIDS

DEFINITION

A cryogenic fluid or cryogen has a boiling point of less than -130°F/-89.9°C at 14.7 psia or an absolute pressure of 101.3 kPa. A cryogen is a liquefied or solidified gas.

PHYSICAL PROPERTIES

<table>
<thead>
<tr>
<th>Cryogen</th>
<th>Temperature at 1 atm (°F/°C/K)</th>
<th>Liquid-Gas Expansion Ratio</th>
<th>Pressure generated from trapped liquid allowed to warm to room temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid O₂ (LOX)</td>
<td>-297 / -183 / 90.2</td>
<td>860 to 1</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Liquid Ar (LAr)</td>
<td>-302 / -186 / 87.3</td>
<td>847 to 1</td>
<td>Not Specified</td>
</tr>
<tr>
<td>Liquid N₂ (LN₂)</td>
<td>-320 / -196 / 77.4</td>
<td>696 to 1</td>
<td>43,000 psig</td>
</tr>
<tr>
<td>Liquid H₂ (LH₂)</td>
<td>-423 / -253 / 20.3</td>
<td>851 to 1</td>
<td>25,000 psig</td>
</tr>
<tr>
<td>Liquid He (LHe)</td>
<td>-452 / -269 / 4.2</td>
<td>757 to 1</td>
<td>18,000 psig</td>
</tr>
</tbody>
</table>

HAZARDS

You must observe a number of general and specific safety practices when working with cryogens. Extremely low temperatures and high gas expansion ratios are generally applicable to all cryogens. However, specific cryogens have issues of reactivity, toxicity, and flammability.

THERMAL (low temperature). Contact with a cryogenic liquid, its off-gases, or components cooled to these low temperatures can readily cause frostbite or cryogenic burns. In addition, the accidental release of these cryogens into the work area can damage equipment and property (e.g., frozen water pipes, damaged flooring, damaged electrical cables and their insulation).

PRESSURIZATION. Cryogenic fluids, confined and allowed to warm, can generate very high pressures. LN₂ confined and allowed to warm up to room temperature will generate a pressure of » 43,000 psig. The pressure similarly generated by LHe is 18,000 psig. Other cryogens behave in similar fashion. Dry Ice can generate hundreds of psig pressure if confined. This points out the potential for rupture of piping or vessels if appropriate venting and pressure relief is not provided. The function of vent lines can be defeated by the formation of ice (from condensed moisture) in the vent line. With LHe, air or other gases can be solidified to form this blockage. If a cryogenic fluid is subjected to a large amount of heat input, a flash vaporization can occur. This will result in a rapid pressure rise that can be described as a BLEVE (boiling liquid expanding vapor explosion). Vents and pressure relief devices should be vented to a safe location, considering the specific cryogen in question, the volume and flow rates of the potential...
releases, and the potential hazards presented by accumulation of the gases or liquids being vented.

OXYGEN DEFICIENCY/ASPHYXIATION. Cryogenic fluids have large liquid to gas expansion ratios, with LN2 » 680 to 1, (based on volume), LHe is » 740 to 1, and LAr » 820. With this in mind, note that any accidental release or overflow of these cryogenic liquids will quickly boil into the gas phase and may create an asphyxiating hazard by displacing the oxygen content of the surrounding area. In the case of LN2, the N2 gas generated from malfunctioning equipment or spills of LN2 will be cold and denser than ambient air. Even well-ventilated lab spaces that have pits or other low-lying (or recessed) areas could have the oxygen displaced by this cold, dense N2 gas. LN2 should not be used below the first floor of a building for this reason. Argon or CO2 will also present these heavier-than-air hazards. Large-volume sources used in small laboratory spaces or in poorly ventilated areas increase the asphyxiation hazard. Oxygen monitors are strongly recommended for areas using inert cryogens; the minimum safe O2 concentration in air is 19.5%.

ICE BUILD-UP. The temperatures associated with cryogenic liquids can easily condense moisture from the air and cause the formation of ice. This ice can cause a malfunction from the design intent of components or systems (e.g., plug vent lines and impede valve operation) or can damage piping systems. In the case of LHe and LH2, air itself can freeze solid and block vent lines. Building exhaust systems accidentally cooled to LN2 temperatures can also be damaged by ice formation or the weight of the accumulated ice and the weight of the LN2 itself. The resultant run-off water when the ice melts can also present a hazard.

MATERIALS CONCERNS. The low temperature of cryogenic liquids will adversely affect the properties of some materials resulting in system or vessel failure. The selection of the materials of construction for vessels and piping systems for cryogen handling should consider the appropriate behavior of the material at the cryogenic temperatures. In general, carbon steels and other bcc-structured metals can become brittle and fracture easily at cryogenic temperatures. Commonly-accepted materials of construction include fcc-structured metals such as the 300 series stainless steels, some of the aluminum alloys, and copper or brass. Plastics, such as Tygon® tubing, become brittle and can easily fail in cryogenic applications. Be sure to consult the appropriate references when selecting materials for cryogenic applications. Even when the appropriate materials are selected, thermal stresses that can lead to failure can be generated in some applications. Thermal gradients across a material or piping system or the rapid cool-down of a vessel can generate thermal stresses. The joining of materials with dissimilar coefficients of expansion can also generate thermal stresses.

OXYGEN ENRICHMENT. LN2 is cold enough to condense the surrounding air into a liquid form. The concentration of O2 in this condensed air is enhanced. This condensed "liquid air" can be observed dripping from the outer surfaces of uninsulated/nonvacuum jacketed lines carrying LN2. This "liquid air" will be composed of > 50% O2, and will amplify any combustion/flammable hazards in the surrounding areas. Open Dewars of
LN2 can condense O₂ from the air into the LN2 and cause an O₂ enrichment of the
liquid, which can reach levels as high as 80% O₂. Air should be prevented from
condensing into LN2 by the use of loose-fitting stoppers or covers that still allow for the
venting of LN2 off-gas. Large quantities of LN2 spilled onto oily surfaces (such as
asphalt) could condense enough O₂ to present a combustion hazard. In some cases,
such as a large-volume LN2 spill onto asphalt, the surface
can become saturated with condensed oxygen and can be shock sensitive (can
detonate when shocked). LHe and LH2 can also condense air into the liquid or even the
solid phase with an enriched O₂ content. Use O₂ monitors to maintain an O₂ level
between 19.5% and 23.5%.

LN2/IONIZING RADIATION FIELD. A unique hazard can result from the use of LN2 in
high ionizing radiation fields where the generation of O₃ or NOₓ may cause a potential
explosion hazard when the LN2 has condensed quantities of O₂ from the atmosphere.
The applicable control measure is to minimize the accumulation of O₂ into the LN2 and
to keep containers free of hydrocarbon contamination.

NOISE TRANSFER. Venting of cryogens can generate, in some cases, noise levels that
could require hearing protection. Sound levels in excess of 150 dBA have been
recorded during routine tank filling. A redesign of the equipment or procedure could also
be addressed in these cases.

ACCIDENTAL RELEASES/SPILLS (OR OVERFLOWS). Accidental releases/spills (or
overflows) of LN2 can present hazards and cause property damage as noted in the
hazards discussed above. This most often is a result of inadequate training on the
specific hazards and procedures. These releases can come from automated level
control systems, but more frequently are the result of manual operations left
unattended. The level of concern over these releases increases with the volume of the
cryogen source. House LN2 systems represent very large quantities with the potential
for release. Separate (stand-alone) supply Dewars are inherently safer in this respect
because they have smaller volumes. Releases into the building or lab space are the
most hazardous, presenting the primary hazards of asphyxiation, personnel exposure,
and property damage may result from significant releases of LN2. When spilled on a
surface, cryogens spread as far as the quantity of liquid spilled and the physical
confines of the area allow. Their vapors spread even further and can present a hazard
to personnel some distance away from the release/spill.

RELEASES INTO BUILDING EXHAUST SYSTEMS. Releases into building exhaust
systems also can present significant hazards. These releases typically occur when the
operator opens a bypass valve in an attempt to precool the piping to LN2 temperatures
and then mistakenly leaves the bypass valve open. These releases can adversely affect
the normal operation of the building’s exhaust system or can cause the exhaust system
to fail and release significant quantities of LN2 into the building’s air space.

ACCIDENTS CAUSED BY EQUIPMENT FAILURE (equipment not designed for
cryogenic service.) Cryogenic fluids should only be handled in apparatus specifically designed for that purpose. Accidents frequently occur where equipment not designed for cryogenic service is used, such as when a consumer-rated Thermos® bottle is used for LN2 or Dry Ice. Over pressure and resultant rupture of the container is frequently the result. These types of accidents can also occur when cryogenic-rated equipment is inappropriately modified and the original safe venting design is compromised.

LIFTING. Physical studies of accident statistics involving cryogenics will always include back strains or other lifting injuries associated with Dewars. Although this hazard is not specifically cryogenic in nature, it is appropriate to note this as a hazard associated with cryogenic applications. Be careful when lifting and moving cryogenic Dewars. The proper use of carts or hand trucks can help prevent these injuries. Alternately, the use of low-pressure liquid transfer equipment and procedures can replace lifting and pouring operations.

BACK INJURIES. Back injuries may result from lifting cryogenic liquid Dewars. Dewars of LN2 or LHe may be accidentally tipped over when crossing obstructions, such as door thresholds. Handle these Dewars with the appropriate care and on the appropriate floor surfaces. Maintain the general condition (wheels, handles, etc.) of the Dewars in proper functioning condition.

OTHER. Specific cryogenic fluids will present specific hazards in addition to the above concerns. Examples include:

- **LOX** and the additional hazards of enhanced combustion, with materials compatibility and cleanliness (hydrocarbon contamination) as added concerns. Do not smoke or allow ignition sources near LOX. LOX is also shock-sensitive. If it spills, do not walk or roll equipment over the spilled area for 30 minutes until the vapors clear. If any clothing is soaked with LOX, remove it immediately and let it air for at least 60 minutes. Keep it away from any ignition sources.
- **LH2** and the additional hazards of flammability and materials embrittlement, with the added concerns of low ignition energy, proper bonding and grounding of equipment, and venting of off-gases. Do not smoke or allow ignition sources near LH2. Ground all electrical equipment according to NFPA 50B or National Electrical Code Article 500 (see References). Allow LH2 off-gassing to a suitable location, preferably outdoors. Do not transfer LH2 from one container to another in an air atmosphere; if you do, then LOX will condense with LH2 and create an explosion hazard. Do not spill LH2, since you will create a flammable vapor cloud. Monitor any areas where you use LH2 with a flammable gas detector.
- Toxicity concerns of CO and F₂.
HANDLING AND PERSONAL PROTECTIVE EQUIPMENT

- Familiarize yourself with the hazards of cryogenic fluids before working with them. Ask an experienced user to show you how to operate Dewars or other cryogenic containers.

- Wear a full face shield over safety glasses to protect your eyes.

- Wear loose-fitting thermal insulated or leather gloves. If they become saturated with a cryogen, you can remove them quickly. Insulated gloves do not allow you to immerse your hands in a cryogen; they are for immediate protection only.

- As always, wear long sleeves, long pants, and completely-closed shoes. If you are moving Dewars, you should wear safety shoes.

- Always handle cryogens carefully. Their extremely low temperatures can produce cryogenic burns and freeze underlying tissue. Exposure to their cold vapors can damage your eyes.

- Always stand clear of boiling vapors or splashed liquids. Boiling and splashing always occur when placing a room-temperature object inside the cryogen and pouring the cryogen into a room-temperature container, so do these operations slowly. Use tongs to place and remove objects inside cryogens.

- Do not touch uninsulated pipes or containers with unprotected hands.

- Never use polystyrene boxes for cryogen storage or transport.

- **Never accompany a transport Dewar in an elevator.** The same procedure to be followed when moving gas cylinders between floors holds for cryogenic fluids transport. Any internal transport involving the use of elevators requires the presence of two people: the first person puts the transport Dewar in the empty elevator and sends the elevator to the destination floor. S/He will not accompany the Dewar. At the receiving end a second person will take the Dewar from the elevator and move it to its final destination.

FIRST AID

DERMAL EXPOSURE. Remove any clothing that may restrict circulation to the affected area. Do not rub frozen tissue. Instead place the affected area in a warm (not hot; < 105°F/40°C) water bath. Do not use dry heat. Seek medical attention immediately. Frozen tissue is usually not painful, but can have a waxy or yellowish appearance. When thawed it will be swollen, painful, and prone to infection. Cover the thawed area with a dry sterile dressing and protect it with bulky clothing pending medical attention. If
large areas of your body are affected, remove your clothing, take a warm shower, and get medical attention immediately.

OCULAR EXPOSURE. Your eyes may be frostbitten. Warm them in a water bath (not hot; < 105°F/40°C) and seek medical attention immediately.

HYPOTHERMIA. In this case, warm the person slowly to avoid shock. Seek medical attention immediately.

REFERENCES/FOR MORE INFORMATION

1. http://www2.iccsafe.org/states/oregon/07_fire/07_PDFs/Chapter%2032_Cryogenic%20Fluids.pdf

Revised 4/2011
SAFE OPERATING PROCEDURE
HAZARDOUS WASTE DISPOSAL

NOTE: This SOP is for chemical waste only. If you have biohazardous waste, refer to the UT Arlington Laboratory Safety Manual. If you have radioactive waste, refer to the UT Arlington Radiation Safety Manual.

INTRODUCTION

UT Arlington hazardous waste policy is not to dispose of any reagents down the drain or sanitary sewer. Direct questions regarding disposal of any waste other than normal "household" trash to the Hazardous Materials Section of EH&S at 817-272-2185.

DISPOSAL OF EMPTY REAGENT CONTAINERS

UT Arlington considers a container “empty” if no significant amount of the contents remains. Pour remaining solutions of liquid reagents. Scrape or drain containers of thick or solidified materials until no more than one inch (2.54 cm) of material remains in the bottom of the container or no more than 3% of the original weight of the contents remains. Deface or remove the container’s original label. You can then dispose of empty container using normal trash collection.

Note: dispose of empty containers for acutely toxic substances via EH&S hazardous waste pickup (see below.)

USE OF HAZARDOUS WASTE CONTAINERS

EH&S distributes 6-liter or 10-liter Nalgene carboys for storage and collection of Halogenated, Non-Halogenated and Aqueous Heavy Metal hazardous liquid waste. These are free of charge and the Chemistry Department can obtain them from the chemistry stockroom. Sharps containers and five-gallon plastic buckets for disposal of solids are available free from EH&S directly (817-272-2185.) EH&S does not provide containers for acids and bases (concentrated corrosives). Containers other than Nalgenes used to accumulate hazardous waste must be in good condition. If the container being used to accumulate hazardous waste is not in good condition, or if it begins to leak, you must transfer the contents to a container that is in good condition.

Hazardous waste containers must be:

- Marked with the words “hazardous waste” and their contents indicated. You must use an EH&S Hazardous Waste Inventory Tag to list the contents. Deface or remove any old labels. Complete this tag before EH&S can pick up the hazardous waste.
- Kept at or near (immediate vicinity) the site of generation and under control of the generator.
- Compatible with contents (for example, acids should not be stored in metal
cans).

- Closed at all times except when waste is added to container.
- Properly identified with completed waste tags before you request pickup.
- Safe for transport with non-leaking screw-on caps.
- Not filled beyond the bottom of the container’s neck.
- Stored with secondary containment.

*Do not overfill waste containers!* Over-filled bottles are hard to pour safely, inclined to burst, likely to leak, and capable of endangering the operator through splashing or shooting up into one's face upon opening. On the EH&S provided containers, "Fill up to the Fill Line -marked on containers."

**HAZARDOUS WASTE ACCUMULATION**

Except when single chemicals are accumulated for recycling or recovery, waste accumulation generally involves bulking several materials into one container. However, keep the following wastes separate (in other words, in separate waste containers):

- non-halogenated materials,
- halogenated materials,
- heavy metals.

EH&S has waste containers labeled for the first three categories. For example, compatible solvents such as acetone, ethanol, acetonitrile, and water can be combined into a single container labeled for non-halogenated materials. If you have chloroform as well, you need to put it into a separate container labeled for halogenated materials. In addition, do not combine chemically incompatible materials into a single waste container. Refer to the chemical compatibility chart. Keep toxic materials, explosive materials, peroxide-formers, pyrophoric materials, corrosives, and pesticides in separate containers.

Safely accumulate hazardous wastes by:

- Clearly marking containers and dating them when accumulation starts.
- Labeling containers with words that clearly identify the contents the FIRST time you put waste into them. Generic names like "waste organics" are acceptable, but keep in mind that you must complete the Hazardous Waste Chemical Inventory Tag listing ALL of the chemical components before EH&S can accept the waste for off-site disposal.
- Separating incompatible wastes streams.
- Keeping waste collection containers closed at ALL times during storage except when adding or removing waste. This is true for solids as well as liquids. Many containers, like beakers or flasks, are not acceptable accumulation containers.
• Designating an area in your lab as a chemical waste accumulation area. Using a hood for this purpose is acceptable as long as there are no experiments in the hood.
• Contacting EH&S for removal of full waste containers from the laboratory. Do not allow large quantities of waste to accumulate in your lab.

Note: Keep waste oil from pumps or other equipment as uncontaminated as possible in order to recycle it. You should keep oils separate from other chemicals, particularly solvents.

LABELING HAZARDOUS WASTE CONTAINERS

*Before EH&S can pick up any chemical waste, you must complete a hazardous chemical inventory tag.* Fill it out and attach it to each waste container. Use the information on the tag to categorize and treat the waste. This applies to both liquid and solid wastes, but sharps containers do not require chemical inventory tags. Please fill the tag out legibly, accurately, and completely. Include the following information:

• Date - Date waste was generated.
• Principal investigator (PI) - Name of the individual responsible for supervising the process generating the waste.
• Building, room number, and phone number.
• Indicate overall volume or weight - Write in the total volume or weight of material in the container.
• Specify chemical contents – List the specific, full chemical name (no formulas or abbreviations) for each chemical constituent in this container. Product names or trade names are acceptable if you can supply the manufacturer’s name and address or an MSDS with the material. Vague statements such as "hydrocarbons," "organic waste," or “various salts of ____” make it impossible to comply with EPA treatment standards and will delay the pickup until you submit sufficiently detailed information to EH&S.
• Amount - Total volume or weight of each chemical constituent in the container.
• Volume % - 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.

REQUEST FOR DISPOSAL

When your container is ready for disposal and is properly tagged, contact EH&S Hazardous Materials Section by sending a request for disposal via:

• Chemical Environmental Management System (CEMS).
• Online. The online Request for Disposal form is available at the following link, [http://policy.uta.edu/index.php?navid=106949&view=109911](http://policy.uta.edu/index.php?navid=106949&view=109911)
EH&S makes pickups regularly and will come to your site within three working days of receiving your request. 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.

Include:

- Facility - Check the appropriate facility.
- Name - Name of the individual responsible for supervising the process of generating the waste. The individual must be a UT Arlington employee.
- Department - Name of department generating the waste.
- Box - Five character code for campus mail. See the front of the UT Arlington 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. See the instructions above.
- Percentage (%) of container - 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%).
- Total amount of contents - Total volume or weight of each chemical in the container.
- Physical state - Indicate if the material is a solid (S) or liquid (L).
- Name - 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. This person must be a UT Arlington employee (for example, faculty, staff, TA, or RA).
- Date - Date when the form was signed and routed to EH&S.

EH&S cannot accept the waste if the you have not completely and correctly filled out both the hazardous chemical inventory tag and request for disposal.

Revised 4/2011
SAFE OPERATING PROCEDURE
LABORATORY CHEMICAL FUME HOODS

INTRODUCTION

A properly-functioning chemical fume hood is one of the most important pieces of laboratory safety equipment. A chemical fume hood can protect lab personnel from inhaling chemical fumes by constantly pulling contaminated air into the hood and exhausting it out of the building. It can also protect users in case of a fire or explosion by helping to physically contain the event.

Chemical fume hoods, while typically classified as engineering controls for air quality, can also be considered as a form of personal protective equipment. Making proper decisions about when hoods should be used, and then using them safely, should be part of your planning for every experiment.

To achieve the maximum operator protection, you must use chemical fume hoods only for the application for which they were designed. Do not use chemical fume hoods for biological work, radioisotopes, chemical storage, spray painting, or any operation incompatible with materials used in the hood construction. For information on these non-chemical fume hood operations, refer to the UTA Laboratory Safety Manual or the UTA Radiation Safety Manual.

Laboratory fume hoods are often the primary control device when using toxic and flammable chemicals in a laboratory. It is important for lab personnel to understand how chemical fume hoods operate so they can use them correctly and avoid undue exposure to hazardous materials. All chemical fume hoods work in the following way:

- 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;
- Air flows up through the ductwork and into the blower, which should be located on the roof;
- Air flows through the exhaust stack and into the atmosphere, away from the building and any air intakes.

FUME HOOD TESTING

EH&S tests laboratory fume hoods semi-annually. Face velocity is a measurement of the average velocity at which air is drawn through the face to the hood exhaust. The minimum face velocity is 100 ft/min and the maximum is 125 ft/min. You can test airflow yourself by taping small pieces of tinsel or Kimwipes to the bottom corner of the sash. Inward movement of the tinsel or Kimwipes indicates that the hood is drawing air inside. Airflow indicators do not determine airflow rate. They only indicate that air is being exhausted through the fume hood.

SAFE USE PROCEDURES

Properly-functioning fume hoods help achieve personnel safety with respect to the hazards of chemical vapors and other harmful airborne substances. Remember that a fume hood is not a storage area. Keeping equipment and chemicals unnecessarily in
the hood may cause airflow blockage. Here are a few health and safety tips concerning fume hoods:

- Verify the exhaust system is operating before each use.
- Verify operation of the fume hood alarm before each use. Do this by temporarily blocking the air sampling port to simulate loss of airflow.
- Substitute toxic chemicals with less hazardous materials whenever possible.
- Keep fume hood exhaust fans on at all times.
- Hoods equipped with a combination vertical and horizontal sash are intended to be used primarily with the vertical frame down and the horizontal moving panels open. Never raise the sash vertically without closing the horizontal panels first.
- Perform all work six inches (15 cm) inside the hood.
- Do not block airflow. Raise large objects 2 inches (5 cm) off the counter by placing them on blocks. This allows airflow underneath and prevents stagnant areas.

- Never place your head inside the hood. No part of your body except your hands and forearms should ever be inside a hood. Leaning into the hood to obtain a better view places your face in closer proximity to the experiment and is particularly dangerous.

- Keep the hood sash closed as much as possible at all times to ensure the optimum face velocity and to minimize energy usage.
- Keep the hood sash pulled down to 18 inches (46 cm) during use. Use the sash as a shield.
- Keep lab doors closed to ensure negative room pressure to the corridor and proper airflow into the hood.
- Do not store reagents or equipment in the hood. You must keep hoods uncluttered. Remove the equipment from one experiment before setting up another.
- Keep the slots of the baffle free of obstruction.

- Avoid rapid movements in front of the hood including opening and closing the fume hood sash rapidly and swift arm and body movements in front of or inside the hood. These actions may increase turbulence and reduce the effectiveness of fume hood containment.
- Do not override or disable mechanical stops on the sash.
- Train and educate personnel regarding specific hazards and include work methods that help reduce contaminant exposure.
- Have a general awareness of the operation of your hood and be aware of any differences in visual or audible cues that may imply a change in function.

**FUME HOOD ALARMS**

Your fume hood must be equipped with a suitable low flow alarm. The low flow alarm is designed to protect you from exposure to hazards by alarming when low face velocity is detected. Do not mute the alarm or otherwise defeat its operation. Such alarms may be
factory supplied, purchased, and calibrated separately.
When the alarm sounds immediately close the sash and step away from the hood. If the alarm does not reset itself, evacuate the area and contact Facilities Management (FM) – call center at 817-272-2000 to submit a work order. There may be a malfunction in the exhaust system serving that hood.
Under certain circumstances, it may be necessary to raise the sash above the established working height to allow materials and apparatus to enter the hood. In this case, wait two minutes after all hazard-generating activity has ceased and all containers of materials are tightly closed. You may then raise the sash as high as needed for setup operations. During this time only, it is safe to temporarily mute the alarm by pressing the enter button.

REFERENCES


Revised 4/2011
SAFE OPERATING PROCEDURE
LABORATORY CHEMICAL SPILLS

INTRODUCTION

The Laboratory Chemical Spill procedures were created to give researchers and laboratory personnel a starting point for developing a chemical spill kit and providing guidance for cleaning up chemical spills. Chemical spills and accidents need to be minimized as much as possible. If a chemical spill should occur, a quick response with a stocked chemical spill kit will help minimize potential harm to personnel, equipment and laboratory space.

PREPARE AND PLAN A SPILL RESPONSE

Refer to the Spill sections in the UT Arlington Emergency Procedures Quick Reference Guide and the UT Arlington Laboratory Safety Manual. Make sure that lab personnel understand these sections. If your lab has specific reagents that require special handling, write your own safe operating procedures (SOP) for these reagents and be sure everyone understands them. Keep all lab procedures, both general and specific, in a readily-accessible location in the lab. Posting them by each telephone is a common spot.

Assemble a spill kit tailored to clean up small spills of chemicals commonly used in your lab. Keep it fully stocked and easily accessible. Train personnel to use its contents and when it is safe to clean up a spill. Restock the spill kit after a spill so you will always have the materials prepared.

- Contents of a spill kit should include appropriate personal protective equipment (PPE), including gloves, disposable lab coats, shoe covers, and safety glasses; absorbent materials made for the reagents in your lab, such as organic solvent or corrosive spill pads, kitty litter, or vermiculite; a plastic (non-sparking) scoop; a broom and dustpan; sodium bicarbonate, citric acid, or a commercial neutralizer such as Spill-X to neutralize spills; materials or equipment for chemicals with special handling requirements (such as mercury); plastic bags to contain the waste; and UTA hazardous waste tags.

Be sure everyone working in the lab knows:

- Locations of fire extinguishers and manual pull stations, eye washes, emergency showers, and telephones;
- How to operate the fire extinguisher and when it's safe to do so;
- How to use the safety shower and eyewash.
EVALUATE THE SPILL

You need to decide if you and/or lab personnel can handle the spill.

Small, incidental spills include spills that can be cleaned up by lab personnel without putting themselves or others in danger. If you are confident you can handle the spill yourself, go to the next section.

Large or extremely dangerous spills include:

- Spills that present an immediate hazard (fire, explosion, chemical exposure, etc.)
- Any spill of highly dangerous reagents
- Moderate or large-scale chemical spills.

If the spill is large or if you are unsure how to classify it, go to the dangerous spill section below.

CLEAN UP SMALL SPILLS

Fortunately, small spills represent the majority of chemical spills in labs. Handle them like this:

- Alert people in the area. Avoid breathing vapors and try to determine what spilled.
- If someone has been splashed with chemicals, immediately flush the affected area with water for at least 15 minutes. Call UTA Police Dispatch, 817-272-3003, and seek medical attention.
- Wear personal protective equipment including appropriate eye protection, gloves, and a long-sleeved lab coat during cleanup.
- Stop the source and confine the spill to a small area. Use a commercial kit or absorbent material from your spill kit to absorb spilled materials. If using a spreadable absorbent such as kitty litter or vermiculite, apply around the edges of the spill and work your way inward.
- Place the saturated absorbent in a plastic bag.
- Label the bag with a chemical waste tag and include it in your next hazardous waste collection.
- Clean the spill area with soap and water.
- Replenish your spill kit supplies so the kit is ready when you need it again.
CLEAN UP LARGE OR DANGEROUS SPILLS

Contact specially-trained personnel and follow chemical spill procedures. Call UT Arlington Police Dispatch, 817-272-3003, and EH&S, 817-272-2185, and report the spill.

- Avoid breathing vapors.
- Quickly identify the spilled material and stop the source if you can do so safely.
- If the spill involves a flammable liquid, turn off all ignition sources if you can do so safely.
- Alert people in the area and evacuate, closing all doors.
- If someone has been splashed with chemicals, flush the affected area with water for at least 15 minutes and seek medical attention.
- Keep people away from the spill area until EH&S responders arrive. Lock doors and post warning signs.
- Have someone available who is knowledgeable about the spilled material to provide information to EH&S responders.

REFERENCES

1. [http://blink.ucsd.edu/Blink/External/Topics/How To/0,1260,14121,00.html](http://blink.ucsd.edu/Blink/External/Topics/How To/0,1260,14121,00.html)
2. UTA Laboratory Safety Manual
3. UTA Emergency Procedures Quick Reference Guide

Revised 4/2011
SAFE OPERATING PROCEDURE
LABORATORY ELECTRICAL EQUIPMENT

INTRODUCTION

Electrically-powered laboratory equipment is indispensible for laboratory operations. Heating mantles, magnetic stirrers, rheostats, vacuum pumps, X-ray units, lasers, and hot plates represent just some of the equipment that can pose an electric shock, explosion, or fire hazard if used improperly.

INSTALLATION AND INSPECTION

Installation of hardwired equipment must be performed by a licensed electrician. All electrical equipment must be certified by a nationally-recognized testing laboratory (such as FM or UL) to ensure that the equipment is free from reasonably foreseeable risk due to electrical hazards. Electrical equipment must not be modified unless explicitly approved by the manufacturer, or inspected by an electrical inspector before being placed in service.

As a minimum, the electrical inspection must insure that:

- Equipment is sufficiently enclosed to prevent accidental contact with energized parts.
- Exposed metal parts are bonded and grounded.
- Over-current protection is appropriate for intended use.
- Connections are tight and insulation intact.

In addition, a competent person within the laboratory should regularly inspect electrical equipment. These visual and physical inspections are to include:

- Obvious damage or defects in the accessories, connectors, plugs, or sockets.
- Flexible cords are effectively anchored to equipment, plugs and sockets.
- Damage to flexible cords:
  - The inner cores of flexible supply cords are not exposed or twisted;
  - The external sheaths are not cut, abraded, twisted, or damaged to such an extent that the inner cores are visible.
- Warning indicators for maximum load on power strips are intact and legible.
- Controls are in good working order, in other words, they are secure, aligned, and appropriately identified.
- Covers and guards are present and secured.
- Ventilation inlets and exhausts are unobstructed.

If upon routine inspection any of the above flaws are detected, the electrical equipment should be immediately removed from service. Contact the equipment vendor, a qualified electrical repair organization, or the Electrical Shop for repair information.
GENERAL SAFETY

All electrical outlets within 6 feet of water must be protected by ground fault circuit interrupters (GFCI). Contact the Electrical Shop to have this protective circuitry installed.

Avoid the use of extension cords. If necessary, extension cord use should be limited to temporary (same-day) use and must be of the proper length and gauge for the intended current. They should not be stretched across floors or located in areas where they can be damaged or pose a tripping hazard. Do not plug extension cords into power stripes.

All faculty and staff working in the lab should be instructed how to de-energize electrical service to equipment in case of an accident or fire.

Lab personnel are not to reset tripped circuit breakers. This must be done by a building engineer or electrician. Breakers should identify the circuit they control. Electrical panel(s) or electric box(s) should remain clear of obstructions at all time.

Electrical equipment used in proximity to flammable liquids and gases must be properly electrically classified. Where possible, use non-sparking induction motors or air motors to operate vacuum pumps, mechanical shakers, stirring motors, and rotary evaporators.

Appliances should be plugged directly into a receptacle and not into power stripes.

Do not use multi-plug adapters. Only power strips with surge protector are permitted. Do not plug power stripes into other power strips (daisy chain).

REFERENCES

1. UTA Electrical Safety http://www.uta.edu/policy/forms/ehs/5electsa.pdf

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SAFE OPERATING PROCEDURE
MERCURY HANDLING

DEFINITIONS

Mercury is a silver liquid metal that vaporizes at temperatures as low as 10°F/-12°C. Mercury vapor is colorless and odorless and may be toxic when inhaled. Most health effects result from chronic exposure; symptoms include fatigue, anorexia, weight loss, inflammation of gums, and tremors. The symptoms of acute overexposure are bronchitis, cough, chest pain, excessive salivation, or metallic taste. Short-term exposures to low-level mercury vapors present little hazard.

A large mercury spill is > 25 mL, such as a broken manometer. For a large spill immediately call EH&S at 817-272-2185 or the University Police at 817-272-3003. Prevent people from walking through the spill area. Notify others to leave the immediate area. Close all doors to the room and wait outside the area for EH&S responders.

A small spill of mercury, such as a broken thermometer, can be cleaned up immediately by laboratory personnel.

SPILL CLEAN-UP

• If your lab work requires you to work with mercury you should obtain a mercury spill kit containing supplies for a mercury cleanup. Mercury spill kits are commercially available and convenient. Refer to Safe Operating Procedure for Laboratory Chemical Spills. At a minimum, you should wear a lab coat, mercury compatible gloves (latex gloves won't protect you from the hazards of Mercury, see glove guide below), and disposable shoe covers during cleanup of mercury spills to prevent skin absorption or contamination of clothing.
• When possible clean up all mercury spills with a specially designed high efficiency particulate air (HEPA)-filtered vacuum with a charcoal filter. EH&S will respond with this equipment when necessary.
• Under no circumstances should you sweep mercury with a broom or vacuum with an ordinary vacuum cleaner. These procedures will disperse mercury vapors and droplets quickly into the air and spread the contamination.
• Clean up very small amounts of mercury using an index card or rubber squeegee to form a larger bead that you can vacuum with a HEPA device or amalgamate.
• You can also collect beads of mercury with a disposable pipette, a water-trapped vacuum line attached to a disposable pipette, or a hand-operated vacuum pump.
• You can use mercury-absorbing powders, if available, to amalgamate mercury in non-accessible locations.
• Place mercury waste and materials used in spill cleanup in a sealed bottle or in a double layer of plastic bags. Label for disposal by EH&S through the chemical waste program.
• After you have collected all visible mercury, wash the area with a detergent solution, rinse, and allow drying before use.
• In areas that you cannot completely clean of mercury, you can apply a sulfur slurry to oxidize the mercury and reduce the possibility for airborne vapors. Vacuum or wet-clean excess sulfur powder during final clean-up after it has had time to react with the mercury.
• Carpets heavily contaminated during a mercury spill may have to be removed if EH&S monitoring of mercury vapor levels after vacuum cleaning determines this need.

DISPOSAL

All mercury and mercury-containing wastes must be packaged, labeled and disposed via the EH&S chemical waste program and according to the University’s Guidelines for Disposal of Chemical Waste. **DO NOT MIX MERCURY COMPOUNDS WITH OTHER SOLVENT WASTE.**

REFERENCES


Revised 4/2011
SAFE OPERATING PROCEDURE
PEROXIDE-FORMING COMPOUNDS

INTRODUCTION

Certain chemical compounds can react with oxygen to create peroxides, compounds that can explode with impact, heat, or friction. Peroxide-forming compounds can be divided into hazard classes based on the method of reaction as described in the Tables below. Follow these guidelines for control and safe use of peroxide-formers.

TABLE 1. Severe peroxide hazard. These reagents can spontaneously decompose and become explosive after exposure to air without concentration. These chemicals must be stabilized or decontaminated and discarded within 3 months of opening.

<table>
<thead>
<tr>
<th>Compound 1</th>
<th>Compound 2</th>
<th>Compound 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isopropyl ether</td>
<td>Potassium amide</td>
<td>Divinylacetylene</td>
</tr>
<tr>
<td>Potassium metal</td>
<td>Sodium amide (sodamide)</td>
<td>Vinilidene chloride</td>
</tr>
<tr>
<td>Butadiene (liquid monomer)</td>
<td>Chloroprene (liquid monomer)</td>
<td>Tetrafluoroethylene (liquid monomer)</td>
</tr>
</tbody>
</table>

TABLE 2. Concentration hazard. These reagents require external energy for spontaneous decomposition. They form explosive peroxides when distilled, evaporated, or otherwise concentrated. Test for peroxides and discard these chemicals within 6 months of opening.

<table>
<thead>
<tr>
<th>Compound 1</th>
<th>Compound 2</th>
<th>Compound 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetal</td>
<td>Diethyl ether</td>
<td>Methyl isobutyl ketone</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>Diethylene glycol dimethyl ether</td>
<td>4-Methyl-2-pentanol</td>
</tr>
<tr>
<td>Benzyl alcohol</td>
<td>(diglyme)</td>
<td>2-Pentanol</td>
</tr>
<tr>
<td>2-Butanol</td>
<td>Dioxanes</td>
<td>4-Penten-1-ol</td>
</tr>
<tr>
<td>Cumene</td>
<td>Ethylene glycol dimethyl ether</td>
<td>1-Phenylethanol</td>
</tr>
<tr>
<td>Cyclohexanol</td>
<td>(glyme)</td>
<td>2-Phenylethanol</td>
</tr>
<tr>
<td>2-Cyclohexen-1-ol</td>
<td>4-Heptanol</td>
<td>2-Propanol</td>
</tr>
<tr>
<td>Cyclohexene</td>
<td>2-Hexanol</td>
<td>Tetrahydrofuran</td>
</tr>
<tr>
<td>Decahydronoraphthalene</td>
<td>Methylacetylene</td>
<td>Tetrahydronaphthalene</td>
</tr>
<tr>
<td>Diacetylene</td>
<td>3-Methyl-1-butanol</td>
<td>Vinyl ethers</td>
</tr>
<tr>
<td>Dicyclopentadiene</td>
<td>Methylcyclopentane</td>
<td>Other secondary alcohols</td>
</tr>
</tbody>
</table>

TABLE 3. Shock and heat sensitive. These reagents are highly reactive and can autopolymerize as a result of internal peroxide accumulation. The peroxides formed in
these reactions are extremely shock- and heat-sensitive. NOTE: The liquid reagents in this group should be tested for peroxides and discarded **within 6 months of opening.**

<table>
<thead>
<tr>
<th>Acrylic acid</th>
<th>Chlorotrifluoroethylene</th>
<th>Vinyl acetate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylonitrile</td>
<td>Methyl methacrylate</td>
<td>Vinylacetylene (gas)</td>
</tr>
<tr>
<td>Butadiene (gas)</td>
<td>Styrene</td>
<td>Vinyl chloride (gas)</td>
</tr>
<tr>
<td>Chloroprene</td>
<td>Tetrafluoroethylene</td>
<td>Vinylpyridine</td>
</tr>
<tr>
<td></td>
<td>(gas)</td>
<td></td>
</tr>
<tr>
<td>Viniladiene chloride</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Many other chemicals may also form peroxides under the right conditions. A list of such chemicals can be found on the EH&S website.**

**NOTE:** These tables and the referenced list represent prominent organic and inorganic compounds that are able to form peroxides under the right conditions. The lists are not comprehensive. You should refer to the MSDS or other reference material, contact the chemical manufacturer, or contact EH&S (817-272-2185) to determine if the chemicals you are using are potential peroxide formers.

**SAFE HANDLING**

- Purchase peroxide-formers with inhibitors added by the manufacturer whenever possible.
- Do not purchase large quantities of peroxide-forming reagents. Purchase the amount that you will use in a 3-month period.
- Date all peroxide-formers upon receipt and again upon opening. Discard peroxide-formers 6 months after opening the containers or 12 months after receipt even if unopened. (Note that peroxide formers in the Table 1 list must be disposed of **within 3 months** after opening.) If within the expiration time frame and no crystal formation or liquid stratification is evident, these chemicals can be properly disposed through UT Arlington’s normal waste disposal procedure. Peroxides in solution in concentrations of less than 1% do not normally present a shock or detonation hazard. These solutions can also be disposed through UT Arlington’s usual procedure.
- **DO NOT OPEN** a container of a peroxide-forming reagent that has obvious crystal formation or liquid stratification. Do not handle the container or force open the lid. Treat the reagent as potentially explosive material. Immediately call EH&S for assistance (817-272-2185).
- Store peroxide-formers (especially those in Table 1) under nitrogen or other inert gas, or keep and use them in an inert atmosphere chamber. **Note:** Some inhibitors actually need small amounts of oxygen to prevent peroxide formation and it is recommended that inhibited chemicals are not stored under an inert atmosphere.
- Store peroxide-formers in sealed, air-impermeable containers such as dark amber glass with a tight-fitting cap. **DO NOT** store these chemicals in open,
partially empty, or transparent containers as these conditions promote formation of peroxides. Containers of peroxide formers should also be stored away from heat and light and protected from physical damage and ignition sources.

- Avoid distillation of peroxide-formers without first testing for the existence of peroxides in the material (see below.) Most explosions with the use of peroxide-formers occur when a material is distilled to dryness. Leave at least 10-20% bottoms. Stir such distillations with a mechanical stirrer or a bubbling inert gas. Air or an oxygen-containing mixture should never be used for bubbling or stirring.
- Use appropriate personal protective equipment (gloves, lab coat, safety glasses) when working with peroxide-formers.

PEROXIDE TESTING

*Commercially available test strips.* You can purchase these from most safety or laboratory supply houses. Some examples include Baxter Scientific, Fisher Scientific, and VWR Scientific.

To use most of these, simply immerse the strip in the suspect material and then compare the color on the strip to the calibration chart that comes with the test kit. This gives a quantitative peroxide concentration, usually in ppm. **Caution:** these strips have finite ranges. You may need to buy several different test kits to cover all possible ranges; read the product information or call the manufacturer for more information.

*Potassium iodide indicator.* Prepare a fresh solution of 10% (by weight) KI in glacial acetic acid. Add 1 mL of this clear, colorless solution to approximately 10 mL of the test material in a clear vial or test tube, shake well, and wait about 30 seconds for color changes to occur.

Peroxides will oxidize the colorless I⁻ to I₂, which gives purple or brownish solutions depending on the solvent. Purple, brown, or purple-brownish colors indicate relatively high concentrations of peroxides and yellowish colors indicate low concentrations.

*Starch-iodide indicator.* This procedure is identical to the KI test shown above, but shows color changes more easily because any iodine that is generated combines with added starch to form an intensely deep blue solution. Perform the test as indicated above, but add 1 drop of a saturated solution of starch in water. A strong blue color indicates peroxides.

You can prepare your own starch-iodide test strips by immersing strips of filter paper into your starch iodide solution and allowing them to dry. Store these away from light in a dry place. Be sure to test these against fresh, dilute H₂O₂ solution so you know they work correctly.

*Sodium Dichromate indicator.* Add no more than 1 milligram of Na₂Cr₂O₇, and 1 drop of
dilute H₂SO₄ to 1 mL of water. Add approximately 10 mL of your ether to your dilute dichromate solution and shake well. The presence of peroxides is indicated by a blue color in the ether layer.

**Ferrous Thiocyanate indicator.** 1. Prepare the following solutions:
- 1% by weight (NH₄)₂Fe(SO₄)₂ in water.
- 1 N H₂SO₄ in water. Caution: always add acid to water, not vice-versa.
- 1 M NH₄SCN in water. To make 1 L of such a solution, add 7.16 g of NH₄SCN to a 1-L volumetric flask and fill to the mark with distilled water. If necessary, decolorize the solution by adding a trace of zinc metal dust.

Combine 5 mL (NH₄)₂Fe(SO₄)₂, 0.5 mL H₂SO₄, and 0.5 mL NH₄SCN. Shake with 6 mL of the suspected material. A red color indicates the presence of peroxides.

**REFERENCES**
1. The US Department of Energy's (DOE) Office of Health, Safety, and Security has two documents that anyone who uses peroxide-forming materials should read thoroughly:
   - Management of Time -Sensitive Chemicals (II): Their Identification, Chemistry and Management.
2. Some good university manuals:
   - Princeton University
   - Michigan State University (179 Kb PDF file) has a larger list of peroxide-formers, notes on inhibition, and recommended storage intervals.
   - Texas A&M University
3. The Canadian Centre for Occupational Health & Safety has a web page titled How Do I Work Safely With Organic Peroxides?

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SAFE OPERATING PROCEDURE
PERSONAL PROTECTIVE EQUIPMENT (PPE)

INTRODUCTIONS AND HAZARDS

Personnel should prepare for a safe laboratory experience by dressing appropriately for laboratory work. This is not a dress code. The goal is to increase your safety by covering as much skin as possible. This way, should you spill or drop something, your clothes will act as a barrier to skin contact. Therefore your clothing is your first protection against hazards. Your laboratory principal investigator (PI) is responsible for ensuring all personnel are safely attired.

NOTE: PPE is not a substitute for safe work practices. PPE will only protect you if you use it.

PERSONAL ATTIRE

- Shoes should fully cover your feet to protect against spills. No open-toed shoes, clogs, flip-flops, Crocs, or sandals are permitted, even in the summer. Leather shoes are the best at protecting your feet.
- Trousers or skirts falling below the knees are required. Shorts are strongly discouraged, but if you must wear shorts, you must wear a lab coat or apron of below-knee length. Preferred materials for attire, aprons, and lab coats are resistant polyester, cotton, or wool, since common laboratory solvents dissolve ordinary polyester and acrylic; fire also melts the latter materials so that they adhere to your skin.
- Wear long sleeves or a lab coat for the same reasons.
- If you wear a necktie, firmly clip it to your shirt or confine it inside a lab coat or apron.
- Avoid loose, flowing garments and scarves. They may easily pick up spills, trail through a burner flame, or get caught in equipment.
- Confine long hair for the same reasons.
- Avoid loose or excessive jewelry. It may catch on equipment. Also avoid ornate rings, bracelets, or watches that can damage protective gloves or make wearing or removing gloves difficult. Your jewelry can also react with common reagents.
- Do not wear contact lenses in a laboratory because chemicals or particulates can get caught behind them and severely damage your eyes. You can also transfer contaminates from your hands to your lenses.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Every laboratory must have available, and your PI must train you in the use of, safety goggles, face shields, gloves, lab coats or aprons, and portable reaction shields.

Goggles and Safety Glasses
Goggles that completely enclose the area of your eyes are required, rather than spectacles, to avoid the possibility of splashes running down your forehead into your eyes. They must be worn at all times when anyone in the laboratory is working with chemicals, as well as when an experiment is running unattended in the laboratory. You can choose specific types of goggles, except that chosen goggles must conform to the American National Standards Institute (ANSI) Z87.1 standard for splash and impact resistance. You may also wear impact-resistant safety glasses. Figure 1 below shows one type of goggles.

*Ordinary prescription eyeglasses will not protect you in the laboratory!* However, you can purchase prescription safety glasses with side shields meeting the ANSI Z87.1 standard from most opticians, such as Lens Crafters or Target. Also, the University has arranged with a vendor to supply prescription safety glasses to personnel at a reduced cost. Contact EH&S, 817-272-2185, for further information.

![Figure 1. An example of safety goggles.](image)

Several spare pairs of goggles should be available for visitors, who are required to wear eye protection while in the laboratory.

*Face Shields*

For work that poses a greater than ordinary danger of splashing, such as handling liquefied gases (cryogenic fluids) or violent reaction, you must wear a hard face shield that protects your entire face as well as your eyes. Wear the face shield over your goggles or safety glasses. Each laboratory must have at least one face shield available at all times. Laboratory personnel and PIs are responsible for determining when this protection is needed. Figure 2 below shows a typical face shield.
Gloves

After your face and eyes, your hands are the most vulnerable parts of your body. Their protection should be routine. You may use disposable gloves for ordinary laboratory operations. Sturdier, less permeable gloves should be selected when working with strong acids or bases or other particularly hazardous materials. Nitrile gloves are preferred.

If you regularly work with sharps, you should wear leather gloves to protect your hands from cuts, abrasions, and scrapes.

Wear insulated gloves (cryoscopic gloves) when handling liquefied gases (cryogenic fluids) or Dry Ice. A laboratory that uses these materials extensively should purchase a pair for personnel.

You should note that disposable gloves are protection from incidental contact with reagents. Gloves do not protect your hands from immersion in a reagent. You should be able to remove gloves quickly in case of an emergency.

In addition to disposable gloves, each laboratory should have available at least one pair of natural rubber gloves and one pair of heavy, impermeable gloves such as Viton. Consult your MSDS or your glove safety chart (http://www.allsaftyproducts.biz/site/323655/page/74172) to select the appropriate pair for the materials with which you are working.

Some common-sense rules for wearing disposable gloves are:

- Select gloves which are resistant to the chemicals to which you may be exposed. Consult the relevant Material Safety Data Sheet (MSDS) which may recommend a particular glove material.
- Select gloves of the correct size and fitting. Gloves that are too small are uncomfortable and may tear, whereas overlarge gloves may interfere with
dexterity. In some cases, such as use of HF, it may be advisable to select gloves that can be removed very rapidly in an emergency.

- Before use, check gloves (even new ones) for physical damage such as tears or pin holes and for previous chemical damage. This is especially important when dealing with dangerous materials such as HF.
- Double-glove when working with corrosives or dangerous reagents. This way, if the top pair becomes damaged or contaminated, the second pair will still protect you.
- When working, you may wash the external surface of the gloves frequently with water if necessary.
- Some gloves, especially lightweight disposables, may be flammable. Keep your hands well away from flames or other high-temperature heat sources.
- When removing gloves, do so in a way that avoids the contaminated exterior contacting your skin.
- Wash your hands after removing gloves.
- Dispose of contaminated gloves properly.
- Do not attempt to reuse disposable gloves.
- Never wear gloves outside of the laboratory or to handle telephones, computer keyboards, etc. You may easily transfer contaminants on your gloves to doorknobs and other common objects. Remove and discard disposable gloves when leaving the lab and select a fresh pair upon returning to the lab.
- Note that you should wash gloves that are not disposable before you remove them. These gloves also should be left in the laboratory.

Lab Coats and Aprons

Wear lab coats or aprons to absorb or deflect spills and prevent corrosive or toxic substances from reaching your skin. Coat vs. apron is largely a matter of personal preference; however, if you wear short sleeves you must wear a coat to protect your arms. Lab coats and aprons must be available to every individual working in a laboratory. A coat’s material is important. Tyvek, a spun, bonded polyester, is the best (most impermeable) material for these garments. On the other hand, if you regularly work with flames or pyrophoric reagents, you must wear a non-flammable lab coat such as Nomex.

Because coats and aprons are uncomfortable in hot weather, lab personnel often avoid using them. Although the best policy is to wear such protection at all times, wearing coats or aprons may be limited to particularly hazardous operations such as use of corrosives, waste disposal, or accident cleanup.

Portable Reaction Shields

Reaction shields are curved sheets of polycarbonate resin with lead bases of such a size that you may set them up in front of a reaction to deflect violent splashes or glass fragments. You must use them whenever you use a potentially explosive reaction (such as one involving peroxides) or one involving especially corrosive materials (such as
fluorosulfonic acid.) You can put a portable shield in front of a fume hood. Figure 3 below shows two examples of portable shields.

![Portable Reaction Shields](image)

**Figure 3. Two Examples of Portable Reaction Shields.**

**REFERENCES:**


Revised 2/2011
SAFE OPERATING PROCEDURE
PIRANHA SOLUTION

INTRODUCTION

A piranha solution is used to remove organic residues from substrates. Two types of solutions are used. The most common is the acid piranha: a 3:1 mixture of concentrated sulfuric acid \((\text{H}_2\text{SO}_4)\) with hydrogen peroxide \((\text{H}_2\text{O}_2)\). Also used is the base piranha: a 3:1 mixture of ammonium hydroxide \((\text{NH}_4\text{OH})\) with hydrogen peroxide \((\text{H}_2\text{O}_2)\).

SPECIAL AUTHORIZATION REQUIRED

Piranha solutions are **VERY DANGEROUS**! Do not attempt to mix and use piranha solutions without training and instruction.

Any users who want to use Piranha solutions **must** be qualified and trained by Principle Investigator/Designated Staff and the training documented. No exceptions.

Any accident regarding the use of Piranha solutions must be reported without delay to EH&S and the lab manager.

HAZARDS

National Fire Protection Association (NFPA) Hazard Ratings:

- **Sulfuric Acid**
  - Health 4
  - Flammability 0
  - Reactivity 2
  - Special Hazard

184
Hydrogen Peroxide

Health 4
Flammability 0
Reactivity 1
Special Hazard Oxidizer

Ammonium Hydroxide

Health 3
Flammability 0
Reactivity 1
Special Hazard

All are equally dangerous when hot, although the reaction in the acid piranha is self-starting whereas the base piranha must be heated to 60 degrees before the reaction begins.

There are many conditions which will cause the reaction to accelerate out of control. "Out of control" can mean anything from the piranha foaming out of its bin and on the deck, to an explosion with a huge shock wave including glove and acid-gown shredding glass sharps.

Piranha's burn (oxidize) organic compounds. If you provide sufficient fuel for them (i.e. photoresist, IPA), they will generate enormous quantities of heat and gas.

PERSONAL PROTECTIVE EQUIPMENT

- The handling of Piranha solutions requires special protection equipment in addition to the standard laboratory clothing (lab coat), gloves, protective eyewear, and leather shoes.
- The additional protective equipment includes: a full face shield, heavy duty rubber gloves (regular Nitrile gloves will not provide sufficient protection), as well as an acid apron to wear on top of the lab coat.
- Legs must be covered (no shorts).
- Leather shoes are strongly recommended. Open toed shoes are strictly forbidden.
PIRANHA SOLUTION HANDLING

Piranha solutions, as well as any corrosive or hazardous substances, can only be used during operational hours and requires at all time the presence of a second knowledgeable user (buddy system).

Containers used during the experiment must be very clearly labeled with the words “Piranha Solution” and the components and percentages of the mixture. A warning sign, visible by any user working under the fume hood, must be posted at all times to indicate that the solution contains a Piranha mixture.

- Mix the solution in the hood with the sash between you and the solution. Wear the full protection.
- Piranha solution is very energetic and potentially explosive. It is very likely to become hot, more than 100 degrees C. Handle with extreme caution. When preparing the piranha solution, always add the peroxide to the acid.
- Leave the hot piranha solution in an open container until cool (a minimum 90 minutes). Never store hot piranha solutions.
- Piranha stored in a closed container without sufficient time to cool could likely explode.
- Adding any acids or bases to piranha or spraying it with water will accelerate the reaction. This includes materials such as Photoresist, which is a strong base.
- Mixing hot piranha with organic compounds such as acetone, photo resist, isopropyl alcohol, and nylon may cause an explosion.
- Do not store wash bottles containing organic compounds on the fume hood deck with piranha solutions.

Piranha Waste Disposal

The primary hazard from storage of piranha waste is the potential for gas generation and over pressurization of the container when the solution is still hot. If you store a hot solution in an air tight container, it will explode!

Therefore, prior to storing the piranha waste solution, it must be left in an open container in order to cool down for a minimum of 15 minutes. It is your responsibility to make sure that the open container is very clearly labeled and left in a safe area for overnight cool down.

Signs alerting anyone of the danger MUST be conspicuously posted. Including:

DO NOT TOUCH
PIRANHA SOLUTION
ABSOLUTELY NO UNAUTHORIZED PERSONNEL
Once cooled down, the solution can be transferred into a closed container for waste storage. The container must be very clearly labeled with the solution name and composition and must include VERY VISIBLE warning signs not to add any other chemical components including water to the waste.

**EMERGENCY RESPONSE**

In case of large exposure, the victim should be removed from the contaminated area, placed under a safety shower while emergency personnel are contacted (Dial 2-3003).

All contaminated clothing should be removed immediately with appropriate gloves and safely discarded.

In case of contact with the skin, the affected area must be immediately rinsed with large amounts of water for at least 15 min.

In case of contact with the eye, irrigate the eye for at least 30 minutes, keeping the eyelids apart and away from eyeballs during irrigation. Place ice pack on eyes until emergency treatment.

In case of inhalation, it may irritate the respiratory tract. Conscious persons should be assisted to an area with fresh, uncontaminated air. Seek medical attention in the event of respiratory irritation, cough, or tightness in the chest. Symptoms may be delayed.

**SPILL RESPONSE**

Use extreme caution. Always wear personal protective equipment while cleaning a spill. Because of the vigorous action of sodium bicarbonate as an acid neutralizer, avoid spatter, and breathing noxious fumes generated by neutralization. Evacuate as necessary until neutralization reaction completes.

- Neutralize with sodium bicarbonate.
- Absorb with an inert material (vermiculite, dry sand, oil-sorb, or kitty litter).

**SUPPLY AND STORAGE**

Do not store piranha. Mix fresh solution for each use. Excess solutions should be disposed as explained in Piranha Waste Disposal.
SAFE OPERATING PROCEDURE
PYROPHORIC REAGENTS
ORGANOLITHIUM REAGENTS

DEFINITION

Pyrophoric materials are those that ignite spontaneously in air below 45°C (130°F). They react with water in the air, oxygen, or both. Pyrophorics can be solid, liquid, or gaseous. Solids and liquids are often stored under kerosene or an inert gas. The pyrophoric hazard increases as the pyrophoric's concentration increases. Examples of pyrophorics include Grignard reagents, metal alkyls and aryls, metal carbonyls, metal powders, metal and nonmetal hydrides, nonmetal alkyls, white phosphorous, silane, phosphine, arsine, borane, diborane, and alkylsilanes. These reagents must be handled to rigorously exclude air and moisture.

HAZARDS

Even for experienced handlers, pyrophorics present risks. The most likely source of moderate to severe injury from direct contact with a pyrophoric is from fire. If the material ignites, a secondary fire can result and damage the surrounding lab areas and beyond. Other common hazards include corrosivity, teratogenicity, water reactivity, and peroxide formation, along with damage to the liver, kidneys, and central nervous system.

HANDLING

TRAINING. All users must be specially trained by their PI/faculty member or experienced user of pyrophorics. Read and understand the MSDS and this SOP before you use the pyrophoric material.

STORAGE. Always store pyrophorics under an inert gas or kerosene. A glove box under N₂ is the best place for them. If you don't have a glove box, a controlled atmosphere bag is acceptable.

- Keep the original shipping container with absorbent and use both to protect the bottle from shocks and spills.
- Do not store pyrophorics with ordinary flammables in a flammable cabinet.
- Do not store pyrophorics near sources of ignition.
- Minimize quantity of pyrophorics necessary in the lab.

OPERATIONS. Assess the risks before you start work with pyrophorics. Detail experiments in advance, especially the technique(s) for material transfers. Several sources are listed in the Reference section of this SOP.

- NEVER work alone when using pyrophorics.
- Use pyrophorics during normal working hours, such as 8-6 M-F.
- Remove all nonessential reagents and equipment from the area where you use pyrophorics.
- Never allow combustible materials to contact pyrophorics at any time.
- Never return unused pyrophorics to the original container. Small amounts of impurities may be introduced into the container, which may cause a fire or explosion.
- Many pyrophoric chemicals release noxious or flammable gases, so handle pyrophorics in a fume hood with a spill tray. Keep the sash at the lowest possible height.
- Conduct operations in a manner to prevent the pyrophoric’s exposure to the atmosphere. Several techniques, depending on the physical state and quantity of pyrophorics used, are available to you. These techniques range from use of gas-tight syringes to glove boxes.
- Transfer pyrophorics by syringe fitted with a lockable needle to prevent the needle from being dislodged accidentally. For the transfer of large amounts use a cannula pressurized by an inert gas. However, carefully avoid over-pressuring containers.
- Use small syringes. If handling more than 20 mL of sample, use a cannula for transfer or use a 20 mL syringe repeatedly.
- Keep dry sand nearby as a fire extinguishing medium. A small beaker or two of sand is useful to extinguish any fire that occurs at the syringe tip and to receive any last drops of reagent from the syringe.
- Evacuated glassware can implode and eject flying glass and splattered chemicals. Conduct vacuum work involving pyrophorics in a fume hood or glove box.
- Vacuum pumps should be rated for use with pyrophoric chemicals.
- Protect mechanical vacuum pumps by using cold traps and, where appropriate, filters to prevent particulate release. Vent the exhaust from the pumps into an exhaust hood.

**PERSONAL PROTECTIVE EQUIPMENT (PPE)**

- Wear chemical splash goggles or safety glasses that meet the Practice for Occupational and Educational Eye and Face Protection (ANSI Z87.1 1989) standard. If the potential for splashing or a highly exothermic reaction exists, wear a face shield over your safety glasses. Ordinary prescription eyeglasses will not provide you with sufficient eye protection.
- In addition, you should use a portable device such as a Unishield to protect your face and body. Safety shielding is required any time a risk of explosion, splashing, or a highly exothermic reaction is present. If you don’t have a portable shield, you must use pyrophoric chemicals in a fume hood with the sash in the lowest feasible position.
- Long Cuff gloves with thin mil nitrile under them are the appropriate hand protection. If these are unavailable, wear nitrile gloves underneath neoprene gloves.
- Do not wear a lab coat or apron made from an easily-ignited material like nylon or polyester. Instead wear a fire-resistant lab coat such as Nomex. Your clothes should be cotton or wool instead of synthetic materials, which when burned melt and adhere to your skin.
- Of course, you should always wear long sleeves, long pants, and completely-closed shoes.

DISPOSAL

- Do not leave a container with any residue of pyrophoric materials open to the atmosphere.
- To destroy pyrophorics, transfer any unused or unwanted materials to an appropriate reaction flask for hydrolysis and/or neutralization with adequate cooling.
- Rinse the essentially empty container three times with an inert dry solvent; then neutralize or hydrolyze this rinse solvent.
- After you triple-rinse the container, leave it open in back of a hood or glove box at a safe location for at least a week. After the week, triple-rinse the container again.
- Dispose of all materials contaminated with pyrophorics as hazardous waste.
- Do not mix neutralized pyrophorics with other hazardous waste, especially flammables. Keep them in a separate container.
- Do not leave pyrophoric waste open overnight in the laboratory. It must be properly contained to prevent fires.
- Call EH&S (817-272-2185) and request pickup of the waste materials that day. Specify that you have pyrophoric waste and that you need same-day pickup.

SMALL SPILLS

Anticipate small spills by having the appropriate cleanup equipment readily available, such as sand. The appropriate cleanup supplies can be determined by consulting the MSDS. You should do this prior to using any pyrophoric chemical. Spill control materials for oxidizers are designed to be inert and will not react with the reagent.

EMERGENCY PROCEDURES

As described above, use dry sand or powdered lime to completely smother and cover any small spill that occurs.

Do not attempt to handle a large spill of pyrophoric materials yourself. Turn off all ignition sources and vacate the laboratory immediately. Call UTA Police Dispatch for assistance, 817-272-3003. Remain on the scene, but at a safe distance, to receive and provide information to safety personnel when they arrive.

The recommended fire extinguisher is a standard dry powder (ABC) type. Class D
extinguishers are recommended for combustible solid metal fires (e.g., Na, LAH), but not for organolithium reagents. Do not use carbon dioxide or water fire extinguishers as these types of extinguishers can actually enhance the combustion of some pyrophoric compounds.

If you are exposed to pyrophoric materials, or on fire, wash yourself with copious amounts of water in the safety shower and seek medical attention immediately.

REFERENCES/FOR MORE INFORMATION

1. Extensive list of pyrophoric compounds http://www.doctorfire.com/Pyrophoric.html
8. http://cameochemicals.noaa.gov/reactivity#Pair_1

Revised 4/2011
SAFE OPERATING PROCEDURE
TOXIC GAS USE IN LABORATORIES

DEFINITION

A toxic gas is immediately dangerous to human and animal life in small quantities. Many toxic gases are colorless, odorless, and tasteless, such as CO. Other toxic gases have characteristic tastes or odors, such as H₂S and its rotten-egg smell.

HAZARDS

Toxic gas storage and usage in a laboratory environment require special handling procedures. Pay attention to the MSDS for each gas. For example, CO has a National Fire Protection Association (NFPA) health hazard rating of 3, which designates a serious health hazard. Inhaling CO can cause headache, dizziness, mental dullness, weakness, bright red face, sleepiness, nausea, vomiting, unconsciousness, and eventually death.

STORAGE

International fire codes prohibit quantities greater than 20 ft³ of highly toxic gases to be stored or used outside of exhausted gas cabinets or certified chemical fume hoods.

- Purchase toxic gases in quantities smaller than 20 ft³ or in quantities that can be easily stored and used in a gas cabinet or chemical fume hood.
- Secure all gas cylinders with an approved chain, strap or floor bracket.
- Some toxic gases, such as CO, are flammable. Store cylinders of flammable gases at least 20 feet from oxidizer gas cylinders (such as oxygen).
- The storage location must have adequate ventilation.
- Refer to Safe Operating Procedure for Compressed Gas Cylinders for additional information on cylinder safety.

DETECTORS/SENSORS

You must continually utilize at least one toxic gas detector in laboratory spaces where toxic gas cylinders are stored and/or actively used.

Check the operation of the detectors monthly and replace the batteries every 6 months.

If the toxic gas cylinders will be operated unattended (for example, during overnight experiments) then gas detectors must be interconnected to the building emergency power source. The regulator should be linked to the building power source that would
enable the regulator to stop the flow of gas in the event of a power outage if the toxic
gas is run unattended.

LABORATORY DOOR SIGNAGE

Place door signage outside of laboratories and storage rooms in which toxic gas
cylinders are stored and/or used.

Include the following room entry requirements on the door sign. For example,
- CARBON MONOXIDE (CO) gas storage.
- Toxic gas.
- The principal investigator’s name and contact information.
- EH&S phone number (817-272-2185) and UTA Police (817-272-3003.)

EMERGENCY PROCEDURES

Do not enter the laboratory upon activation of the toxic gas alarm. Wait for authorized
equipment personnel.

After an alarm sounds, EH&S, emergency responders, or other personnel equipped with
portable gas detection equipment must conduct air quality measurements prior to
entrance into the laboratory or storage site.

Upon clearance, authorized personnel are permitted to enter the laboratory or storage
room to facilitate necessary repairs to equipment or gas cylinders.

REFERENCES

1. Compressed Gas SOP

Revised 4/2011
SAFE OPERATING PROCEDURE
FLAMMABLE LIQUIDS STORAGE LIMIT GUIDE

The following guidelines have been developed for the safe handling, storage and use of flammable and combustible liquids in the laboratory. This information was extracted from the regulatory standards established under 29 CFR 1910.106, NFPA 30 and NFPA 45.

Definitions
Flammable Liquid

Class IA liquids have a flash point at or below 73°F (22.8°C) and a boiling point at or below 100°F (37.8°C).

Class IB liquids have a flash point at or below 73°F (22.8°C) and a boiling point at or above 100°F (37.8°C).

Class IC liquids have flash points at or above 73°F (22.8°C) but below 100°F (37.8°C).

Combustible Liquid

Class II liquids have a flash point at or above 100°F (37.8°C) and below 140°F (60°C).

Class IIIA liquids have a flash point at or above 140°F (60°C) and below 200°F (93°C).

Class IIIB liquids have a flash point at or above 200°F (93°C).

Note: The flammability concern of Class IIIB liquids is so low that they do not usually present a fire hazard of these materials. Therefore this classification is not in the storage limits tables below. See "List of Flammable Liquids by Classification" for specific liquids in each class.
Storage Limits

Maximum quantities of flammable and combustible liquids and liquefied flammable gases in laboratory areas shall be in accordance with Table 1.

**TABLE 1**

<table>
<thead>
<tr>
<th>Lab Type</th>
<th>Flammable and Combustible Liquid Class</th>
<th>MAXIMUM QUANTITY ALLOWED OUTSIDE OF A STORAGE CABINET (Excluding Quantities in a Storage Cabinet or Safety Can)</th>
<th>TOTAL QUANTITY ALLOWED IN A LABORATORY (Including Quantities in Storage Cabinets or Safety Cans)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maximum quantity per 9.3 m² (100 ft²) of Laboratory Unit</td>
<td>Maximum quantity per 9.3 m² (100 ft²) of Laboratory Unit</td>
</tr>
<tr>
<td>Instructional</td>
<td>I</td>
<td>7.5 (2)</td>
<td>15 (4)</td>
</tr>
<tr>
<td></td>
<td>I, II, IIIA</td>
<td>15 (4)</td>
<td>30 (8)</td>
</tr>
<tr>
<td>Research</td>
<td>I</td>
<td>20 (5)</td>
<td>38 (10)</td>
</tr>
<tr>
<td></td>
<td>I, II, IIIA</td>
<td>38 (10)</td>
<td>76 (20)</td>
</tr>
<tr>
<td>CTY*</td>
<td>I</td>
<td>4 (1)</td>
<td>7.5 (2)</td>
</tr>
<tr>
<td></td>
<td>I, II, IIIA</td>
<td>4 (1)</td>
<td>7.5 (2)</td>
</tr>
</tbody>
</table>

*When being used for CTY or for any instruction of grades 12 and below. Maximum container size shall be in accordance with Table 2.
## Table 2

<table>
<thead>
<tr>
<th>Container Type</th>
<th>Flammable Liquids</th>
<th>Combustible liquids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IA</td>
<td>IB</td>
</tr>
<tr>
<td>Glass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>500mL (1pt)*</td>
<td>1L (1qt)*</td>
<td>4L (1.1Gal)</td>
</tr>
<tr>
<td>Metal or Approved Plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4L (1.1Gal)</td>
<td>20L (5Gal)</td>
<td>20L (5Gal)‡</td>
</tr>
<tr>
<td>Safety Cans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10L (2.6Gal)</td>
<td>20L (5Gal)‡</td>
<td>20L (5Gal)‡</td>
</tr>
<tr>
<td>Metal Drums (DOT spec)</td>
<td>N/A</td>
<td>20L (5Gal)‡</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>4L (1.1Gal)</td>
<td>20L (5Gal)‡</td>
</tr>
</tbody>
</table>

*Glass containers as large as 4L (1.1 gal) shall be permitted to be used if needed and if the required purity would be adversely affected by storage in a metal or an approved plastic container, or if the liquid would cause excessive corrosion or degradation of a metal or an approved plastic container.

‡ In instructional or CTY laboratory work areas, no container for Class I or Class II liquids shall exceed a capacity of 4 L (1.1 gal). Safety cans shall be permitted to have an 8 L (2.1 gal) capacity.

| Note: Flammable liquids requiring refrigerated storage must be stored in UL Listed refrigerators specifically designed for the storage of flammable materials. Contact EHS for information regarding specific refrigerator storage concerns. |

### Handling

- Flammable liquids shall be kept in covered containers when not actually in use.

- Transfer operations must be provided with adequate ventilation. Sources of ignition are not permitted in areas where flammable vapors may travel.

- Bulk dispensing of flammable liquids into or out of drums require the use of a grounding and bonding system. Contact EHS for specific grounding and bonding information.
Use

- Eliminate sources of ignition (i.e. open flames, hot plates, etc.) from work areas where flammable and combustible liquids are used.

- All manipulations of flammable liquids which pose a risk of explosion, splash hazard, or a highly exothermic reaction should occur in a fume hood with the sash in the lowest feasible position.

- Safety shielding is required any time there is a risk of explosion, splash hazard, or a highly exothermic reaction. Portable shields, which provide protection to all laboratory occupants, are acceptable.

- Eye protection in the form of safety glasses must be worn at all times when handling flammable liquids.

- Gloves should be worn when handling flammable liquids.Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact EH&S for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated.

- Transfer flammable and combustible liquids in a functioning fume hood.

- Ethers shall be used ONLY in a working fume hood from which all possible ignition sources have been removed.

Safe Handling of Flammable Gases

NFPA sets limitations on the number of cylinders that should not be exceeded in a laboratory. Do not acquire more than:

- three 10" x 50" flammable gas or oxygen cylinders and
- three 4" x 15" cylinders of toxic gases (such as arsine, chlorine, fluorine, hydrogen cyanide, nitric oxide)
- NFPA allows for the use of liquefied petroleum gas cylinders within the lab, however, Texas laws state that no liquefied petroleum gases (i.e., C₃ or C₄ such as butanes, propanes, etc.) may be kept within an occupied building.
## List of Flammable Liquids by Classification

The following list of flammable and combustible liquids was developed to assist users in the proper classification and storage of flammable and combustible liquids in the laboratory. This information is meant to be an illustrative list of common flammable and combustible liquids. If you are unsure of the material classification of materials you are working with, contact EH&S at 272-2185.

| **Class IA Flammable Liquids** (Flash point at or below 73 F, boiling point at or below 100 F) |
|---|---|---|
| 1-1 Dichloroethylene | Ethyl Chloride | Pentane |
| Acetaldehyde | Isopentane | Petroleum Ether |
| Collodion | Isopropyl Chloride | Propylene Oxide |
| Ethylamine | Methyl Ethyl Ether |  |
| Ethyl Ether | Methyl Formate |  |

| **Class IB Flammable Liquids** (Flash point below 73 F, boiling point at or below 100 F) |
|---|---|---|
| Acetone | Gasoline | Octane |
| Benzene | Hexane | Propyl Acetate |
| Butyl Alcohol | Methyl Acetate | Isopropyl Acetate |
| Carbon Disulfide | Methyl Alcohol | Isopropyl Alcohol |
| 1,2-Dichloroethylene | Methylcyclohexan | Toluene |
| Ethyl Acetate | Methyl Ethyl Ketone | Butyl Acetate |
| Ethyl Alcohol | Methyl Propyl Ketone |  |
| Ethyl Benzene | VM&P Naphtha |  |

| **Class IC Flammable Liquids** (Flash point at or below 73 F, boiling point at or below 100 F) |
|---|---|---|
| Amyl Acetate | Isopropanol | Styrene (Monomer) |
| Amyl Alcohol | Methyl Alcohol | Turpentine |
| Butyl | Methyl Isobutyl Ketone | Xylene |
| Dibutyl Ether | Naptha |  |
| Isoamyyyl Acetate | Propyl Alcohol |  |

| **Class II Combustible Liquids** (Flash point at or above 100 F, and below 140 F) |
|---|---|---|
| Acetic Acid | Hydrazine | Methyl Lactate |
| Camphor Oil | Kerosene | Mineral Spirits |
| Cellosolve Acetate | Naptha (coal tar) | Varsol |
| Cyclohexane | Naptha (high flash) |  |
| Fuel Oil #1, 2, 4 & 5 | Methyl Cellosolve |  |

<p>| <strong>Class III A Combustible Liquids</strong> (Flash point at or above 140 F, and below 200 F) |
|---|---|---|
| Aniline | Formic Acid | Isophorone |
| Butyl Cellosolve | Furfural | Nitrobenzene |
| Carbolic Acid | Furfuryl Alcohol | Phenol |</p>
<table>
<thead>
<tr>
<th>Cyclohexanol</th>
<th>Naphthalenes</th>
<th>Pine Oil</th>
</tr>
</thead>
</table>

**Class III B Combustible Liquids** (Flash point at or above 140 F, and below 200 F)

<table>
<thead>
<tr>
<th>Cellosolve Solvent</th>
<th>Formalin</th>
<th>Picric Acid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethylene Glycol</td>
<td>Glycerine</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX

I. Sample MSDS
II. Examples of Potentially Incompatible Waste
III. List of Explosives
IV. List of Peroxide Forming Compounds
V. Definition of Hazardous Waste
VI. List of Acutely Hazardous Chemicals
VII. CEMS Request for Waste Removal
VIII. Hazardous Chemical Inventory Tag
IX. Sample of Completed Chemical Inventory Tag
X. Laboratory Safety Evaluation
XI. Site Specific Training Form
1 - PRODUCT IDENTIFICATION

PRODUCT NAME: ACETONE
FORMULA: (CH3)2CO
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

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>%</th>
<th>CAS NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACETONE</td>
<td>90-100</td>
<td>67-64-1</td>
</tr>
</tbody>
</table>

3 - PHYSICAL DATA

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

APPENDIX I
MELTING POINT: -95°C (-139°F)  VAPOR DENSITY (AIR=1): 2.0
SPECIFIC GRAVITY: 0.79  EVAPORATION RATE: ~10
(H2O=1)  (BUTYL ACETATE=1)
SOLUBILITY (H2O): 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/M3 (750 PPM)
SHORT-TERM EXPOSURE LIMIT (STEL): 2375 MG/M3 (1000 PPM)
PERMISSIBLE EXPOSURE LIMIT (PEL): 2400 MG/M3 (1000 PPM)
TOXICITY: LD50 (ORAL-RAT)(MG/KG) - 9750
LD50 (ORAL-MOUSE)(MG/KG) - 3000
LD50 (IPR-MOUSE)(MG/KG) - 1297
LD50 (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.

<table>
<thead>
<tr>
<th>Group 1-A</th>
<th>Group 2-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylene sludge</td>
<td>Any waste in Group 1-A or 1-B</td>
</tr>
<tr>
<td>Alkaline caustic liquids</td>
<td>Potential consequences: Fire or explosion; generation of flammable hydrogen gas.</td>
</tr>
<tr>
<td>Alkaline cleaner</td>
<td></td>
</tr>
<tr>
<td>Alkaline corrosive liquids</td>
<td>Group 3-A</td>
</tr>
<tr>
<td>Alkaline corrosive battery fluid</td>
<td>Alcohols</td>
</tr>
<tr>
<td>Caustic wastewater</td>
<td>Water</td>
</tr>
<tr>
<td>Lime sludge and other corrosive alkalies</td>
<td></td>
</tr>
<tr>
<td>Lime wastewater</td>
<td>Group 3-B</td>
</tr>
<tr>
<td>Lime and water</td>
<td>Any concentrated waste in Groups 1-A or 1-B</td>
</tr>
<tr>
<td>Spent caustic</td>
<td>Calcium</td>
</tr>
<tr>
<td></td>
<td>Lithium</td>
</tr>
<tr>
<td></td>
<td>Metal hydrides</td>
</tr>
<tr>
<td></td>
<td>Potassium</td>
</tr>
<tr>
<td></td>
<td>SO_2Cl_2, SOCl_2, PCl_3, CH_3SiCl_3</td>
</tr>
<tr>
<td></td>
<td>Other water-reactive waste</td>
</tr>
<tr>
<td></td>
<td>Potential consequences: Fire, explosion, or heat generation; generation of flammable or toxic gases.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group 1-B</th>
<th>Group 2-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acid sludge</td>
<td>Alcohols</td>
</tr>
<tr>
<td>Acid and water</td>
<td>Aldehydes</td>
</tr>
<tr>
<td>Battery acid</td>
<td>Halogenated hydrocarbons</td>
</tr>
<tr>
<td>Chemical cleaners</td>
<td>Nitrated hydrocarbons</td>
</tr>
<tr>
<td>Electrolyte, acid</td>
<td>Unsaturated hydrocarbons</td>
</tr>
<tr>
<td>Etching acid liquid or solvent</td>
<td>Other reactive organic compounds and solvents</td>
</tr>
<tr>
<td>Pickling liquor and other corrosive acids</td>
<td>Group 4-B</td>
</tr>
<tr>
<td>Spent acid</td>
<td>Concentrated Group 1-A or 1-B wastes</td>
</tr>
<tr>
<td>Spent mixed acid</td>
<td>Group 2-A wastes</td>
</tr>
<tr>
<td>Spent sulfuric acid</td>
<td></td>
</tr>
<tr>
<td>Potential consequences: Heat generation; violent reaction.</td>
<td></td>
</tr>
</tbody>
</table>
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
Nitrites
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.

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)
Azodisobutryonitrile
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
Diazenidinophenolen, wetted with not less than 40 percent water or mixture of alcohol and water, by mass
Diethyleneeglycol dinitrate, desensitized (with not less than 25 percent non-volatile water-insoluble phlegmatizer, by mass
Dinitroglycerulri (or) Dingu
Dinitrophenolen, (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 phlegmetizer
Dinitrosobenzene
Dipicyr sulfide, (dry or wetted with less than 10 percent water, by mass)
Guanyl nitrosaminoguanylidene hydrazine, wetted (with not less than 30 percent water, by mass)
Guanyl nitrosaminoguanyltetrazene, 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 mononitroresorcindate
Lead styphnate, wetted (or) Lead trinitroresorcinate, 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)
Nitrosoquianidine
Nitrostarch, (dry or wetted with less than 20 percent water, by mass)
Explosives (continued)

Nitrotiazolone (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)
PEROXIDE-FORMING COMPOUNDS

Introduction
Certain chemical compounds can react with oxygen to create peroxides, compounds that can explode with impact, heat, or friction. Peroxide-forming compounds can be divided into hazard classes based on the method of reaction as described in the Tables below. Follow these guidelines for control and safe use of peroxide-formers.

TABLE 1. Severe peroxide hazard. These reagents can spontaneously decompose and become explosive after exposure to air without concentration. These chemicals must be stabilized or decontaminated and discarded within 3 months of opening.

<table>
<thead>
<tr>
<th>Isopropyl ether</th>
<th>Potassium amide</th>
<th>Divinylacetylene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium metal</td>
<td>Sodium amide</td>
<td>Vinylidene chloride</td>
</tr>
<tr>
<td>(sodamide)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butadiene (liquid monomer)</td>
<td>Chloroprene (liquid monomer)</td>
<td>Tetrafluoroethylene</td>
</tr>
<tr>
<td>(liquid monomer)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 2. Concentration hazard. These reagents require external energy for spontaneous decomposition. They form explosive peroxides when distilled, evaporated, or otherwise concentrated. Test for peroxides and discard these chemicals within 6 months of opening.

<table>
<thead>
<tr>
<th>Acetal</th>
<th>Diethyl ether</th>
<th>Methyl isobutyl ketone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetaldehyde</td>
<td>Diethylene glycol</td>
<td>4-Methyl-2-pentanol</td>
</tr>
<tr>
<td>Benzyl alcohol</td>
<td>dimethyl ether</td>
<td></td>
</tr>
<tr>
<td>2-Butanol</td>
<td>Dioxanes</td>
<td>2-Pentanol</td>
</tr>
<tr>
<td>Cumene</td>
<td>Ethylene glycol</td>
<td>4-Penten-1-ol</td>
</tr>
<tr>
<td>(diglyme)</td>
<td>dimethyl ether</td>
<td>1-Phenylethanol</td>
</tr>
<tr>
<td>Cyclohexanol</td>
<td>(glyme)</td>
<td>2-Phenylethanol</td>
</tr>
<tr>
<td>2-Cyclohexen-1-ol</td>
<td>4-Heptanol</td>
<td>2-Propanol</td>
</tr>
<tr>
<td>Cyclohexene</td>
<td>2-Hexanol</td>
<td>Tetrahydrofuran</td>
</tr>
<tr>
<td>Decahydronaphthalene</td>
<td>Methylacetylene</td>
<td>Tetrahydronaphthalene</td>
</tr>
<tr>
<td>Diacetylene</td>
<td>3-Methyl-1-butanol</td>
<td>Vinyl ethers</td>
</tr>
<tr>
<td>Dicyclopentadiene</td>
<td>Methylcyclopentane</td>
<td>Other secondary alcohols</td>
</tr>
</tbody>
</table>

TABLE 3. Shock and heat sensitive. These reagents are highly reactive and can autopolymerize as a result of internal peroxide accumulation. The peroxides formed in these
reactions are extremely shock- and heat-sensitive. NOTE: The liquid reagents in this group should be tested for peroxides and discarded within 6 months of opening.

<table>
<thead>
<tr>
<th>Acrylic acid</th>
<th>Chlorotrifluoroethylene</th>
<th>Vinyl acetate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylonitrile</td>
<td>Methyl methacrylate</td>
<td>Vinylacetylene (gas)</td>
</tr>
<tr>
<td>Butadiene (gas)</td>
<td>Styrene</td>
<td>Vinyl chloride (gas)</td>
</tr>
<tr>
<td>Chloroprene</td>
<td>Tetrafluoroethylene</td>
<td>Vinylpyridine</td>
</tr>
<tr>
<td></td>
<td>(gas)</td>
<td></td>
</tr>
<tr>
<td>Vinyladiene chloride</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Many other chemicals may also form peroxides under the right conditions. A list of such chemicals can be found on the EH&S [website](https://www.ehs.utsa.edu/).

**NOTE:** These tables and the referenced list represent prominent organic and inorganic compounds that are able to form peroxides under the right conditions. The lists are not comprehensive. You should refer to the MSDS or other reference material, contact the chemical manufacturer, or contact EH&S (817-272-2185) to determine if the chemicals you are using are potential peroxide formers.

For additional information refer to the UT Arlington **SOP for Peroxide forming compounds**
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

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

**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.*

*APPENDIX V*
List of Acutely Hazardous Waste

Acetaldehyde, chloro-
Acetamide, N-(aminothioxomethyl)-
Acetamide, 2-fluoro-
Acetic acid, fluoro-, sodium salt
1-Acetyl-2-thiourea
Acrolein
Aldicarb
Aldrin
Allyl alcohol
Aluminum phosphate (R,T)
5-(Aminomethyl)-3-isoxazolol
4-Aminopyrimidine
Ammonium picrate (R)
Ammonium vanadate
Argentate(1-), bis(cyanoo-C)-potassium
Arsenic acid H_3AsO_4
Arsenic oxide As_2O_3
Arsenic oxide As_2O_5
Arsenic pentoxide
Arsenic trioxide
Arsine, diethyl-
Arsinous dichloride, phenyl-
Aziridine
Aziridine, 2-methyl-
Barium cyanide
Benzenamine, 4-chloro-
Benzamine, 4-nitro-
Benzene, (chloromethyl) -
1,2-Benzenedioli, 4-[1-hydroxy-2- (methyl-
amino)ethyl]-, (R)
Benzenethaneamine, alpha, alpha- dimethyl-
Benzenethiol
2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-
phenyl-butyl)-, & salts, when present at concen-
trations greater than 0.3%
Benzyl chloride
Beryllium
Bromoaceton
Brucine
2-Butanone, 3,3-dimethyl-1-(methylthio)-,
O- [(methylamino)carbonyl] oxime
Calcium cyanide
Calcium cyanide Ca(CN)_2
Carbon disulfide
Carbonic dichloride
Chloroacetaldehyde
p-Chloroaniline

1-(o-Chlorophenyl)thiourea
3-Chloropropionitrile
Copper cyanide
Copper cyanide Cu(CN)
Cyanides (soluble cyanide salts), not otherwise
specified
Cyanogen
Cyanogen chloride
Cyanogen chloride (CN)Cl
2-Cyclohexyl-4,6-dinitrophenol
Dichloromethyl ether
Dichlorophenylarsine
Dieldrin
Diethylarsine
Diethyl-p-nitrophenyl phosphate
O,O-Diethyl O-pyrazinyl phosphorothioate
Diisopropylfluorophosphate (DFP)
1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-
hexachloro 1,4,4a,5,8a-hexahydro-,
(1alpha,4alpha,4abeta,5alpha,8alpha, 8beta)-
1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-
hexachloro 1,4,4a,5,8a-hexahydro-
(1alpha,4alpha,4abeta,5beta,8beta,8beta, 8beta)-
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-,
(1alpha,2beta,2alpha,3beta,6beta, 6alpha,7beta,7alpha)-
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-,
(1alpha,2beta,2alpha,3alpha,6alpha,6ab
ea,7beta,7alpha)-, &metabolites

Dimethonate
alpha, alpha-Dimethyl-phenethylamine
4,6-Dinitro-o-cresol, & salts
2,4-Dinitrophenol

Dinoseb
Diphosphoramidine, octamethyl-
Diphosphoric acid, tetraethyl ester
Disulfoton
Dithiobiuret
Endosulfan
Endothall
Endrin

APPENDIX VI
Endrin, & metabolites
Epinephrine
Ethanedicarbonimidooxymethylene diphenylcarbinol, 2,4,6-trinitro-
Ethyl cyanide
Ethaneimidothioic acid, N-(methylamino)carbonyloxacyclo-
yl 
Ethanolamine, 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, hydrazine
Isonicotinamide
3(2H)-Isoxazolone, 5-(aminomethyl)-
Mercury, (acetato-O)phenylen-
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-ben-zodioxathiepin, 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)₄, (T-4)-
Nickel cyanide
Nickel cyanide Ni(CN)₂
Nicotine, & salts
Nitric oxide
p-Nitroaniline
Nitrogen dioxide
Nitrogen oxide NO
Nitrogen oxide NO₂
Nitroglycerine (R)
N-Nitrosodimethylamine
N-Nitrosomethylvinylamine
Octamethylpyrophosphoramide
Osmium oxide OsO₄,(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
Phlorate
Phosgene
Phosphine
Phosphoric acid, diethyl ester (4-nitrophenyl ester)
Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester
Phosphorodithioic acid, O,O-diethyl S-[ethylthio)methyl ester
Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester
Phosphorofluoridic acid, bis(1-methyl-ethyl) ester
Phosphoroxylic acid, O,O-diethyl O-(4-nitrophenyl) ester
Phosphoroxylic acid, O,O-diethyl O-pyrazinyl ester
Phosphoroxylic acid, O-[4-
[(dimethylamino)sulfonyl]phenyl] O,O-
dimethyl ester
Phosphoroxylic acid, O,O-dimethyl O-(4-nitrophenoxy)-ester
Phosphoroxylic acid, O,O-dimethyl O-(4-nitrophenoxy)-ester
Phosphoroxylic acid, O,O-dimethyl O-(4-nitrophenoxy)-ester
Plumbane, tetraethyl-
Potassium cyanide
Potassium cyanide K(CN)
Potassium silver cyanide
Propanal, 2-methyl-2-(methylthio)-O-[[(methylamino)carbonyl] oxime
Propanenitrile
Propanenitrile, 3-chloro-
Propanenitrile, 2-hydroxy-2-methyl-
1,2,3-Propanetriol, trinitrate (R)
2-Propanone, 1-bromo-
Propanal alcohol
2-Propanol
2-Propen-1-ol
1,2-Propyleneimine
2-Propyn-1-ol
4-Pyridinamine
Pyridine, 3-(1-methyl-2-pyrroldinyl)-,(S)-, & salts
Selenious acid, dithallium(1+) salt
Selenourea
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
Tetraethylthiopyrophosphate
Tetraethyl lead
Tetraethyl pyrophosphate
Tetranitromethane (R)
Tetraphosphoric acid, hexaethyl ester
Thallic oxide
Thallium oxide Tl₂O₃
Thallium (I) selenite
Thallium (I) sulfate
Thiodiphosphoric acid, tetraethyl ester
Thiofanox
Thimidodicarbonic diamide [(H₂N)C(S)]₂NH
Thiophenol
Thiosemicarbazide
Thiourea, (2-chlorophenyl)-
Thiourea, 1-naphthalemyl-
Thiourea, phenyl-
Toxaphene
Trichloromethanethiol
Vanic acid, ammonium salt
Vanadium oxide V₂O₅
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 Zn₃P₂, when present at concen-
rations greater than 10% (R,T)
HAZARDOUS CHEMICAL INVENTORY TAG

(Please Print)

Principal Investigator__________________________

Phone:__________________________

Bldg__________ Rm No.__________

INDICATE OVERALL VOLUME OR WEIGHT:
LIQUID: _______ 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.)

AMOUNT.

<table>
<thead>
<tr>
<th>Substance</th>
<th>(g, KG, ml, L)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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)
STANDARD OPERATING PROCEDURE
Request for Chemical Waste Removal

Step 1: Log into the Chemical Environmental Management System (CEMS) http://cems.uta.edu

Step 2: Sign-in by selecting your email address and using your CEMS password.

Step 3: Click “request waste removal” in the section “Hazardous Waste”.

Step 4: Fill out the “Hazardous Waste Pickup Request Form” by choosing your name (or the name of your supervisor) under “Principal Investigator” and the location of the waste under “Pick-up Location” (Department usually displays automatically).

Step 5: In the “chemical substance” windows list the containers with waste starting with the HAZARDOUS WASTE CHEMICAL INVENTORY TAG # (red-5-digit-Waste-Tag-number) as shown in the example below. These Waste Tags are provided by EH&S and need to be filled out and attached to every container with waste.

Choose # of containers, amount, and unit.

In the “Comments” window list the chemicals of each container in more detail (indicate the concentration) as shown in the example below. Do not use abbreviations.

Use the same “Comments” window to request empty waste containers if needed.

### Hazardous Waste Pickup Request

<table>
<thead>
<tr>
<th>Principal Investigator</th>
<th>Rowlett, Elizabeth</th>
<th>other:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(request on behalf of)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Department</td>
<td>Chemistry</td>
<td>other:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pick-up Location</td>
<td>Environmental Health &amp; Safety office</td>
<td>other:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Tag # 36723: non-halogenated waste | 1 | 10 | 1 | other: |

Issued 03/03/2011
Revised 03/04/2013
<table>
<thead>
<tr>
<th>Tag #</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>36724</td>
<td>Halogenated waste</td>
<td>1</td>
<td>gals</td>
<td></td>
</tr>
<tr>
<td>36725</td>
<td>Heavy metals</td>
<td>1</td>
<td>gals</td>
<td></td>
</tr>
<tr>
<td>36726</td>
<td>Ethidium Bromide waste</td>
<td>1</td>
<td>gals</td>
<td></td>
</tr>
<tr>
<td>36727</td>
<td>Used oil</td>
<td>1</td>
<td>gals</td>
<td></td>
</tr>
<tr>
<td>36728</td>
<td>Nitric Acid, 70%</td>
<td>1</td>
<td>gals</td>
<td></td>
</tr>
<tr>
<td>36729</td>
<td>Hydrochloric Acid, 1 M</td>
<td>1</td>
<td>gals</td>
<td></td>
</tr>
<tr>
<td>36730</td>
<td>Sodium Hydroxide, 0.5 M</td>
<td>1</td>
<td>gals</td>
<td></td>
</tr>
<tr>
<td>36731</td>
<td>Developer (acidic), 100%</td>
<td>1</td>
<td>gals</td>
<td></td>
</tr>
<tr>
<td>36732</td>
<td>Developer (alkaline), 100%</td>
<td>1</td>
<td>gals</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

Tag # 36723: Acetone, Propanol, Ethanol;
Tag # 36724: Chloroform, Methylene chloride;
Tag # 36725: Nickel sulfate; Chromium Chloride;
Please provide a new 5 gal bucket for Ethidium Bromide gels/solid waste and 3 empty 10 L Nalgene bottles.

Step 6: Click “submit”. The message will be sent to a CEMS Administrator and your request will be completed within 3 working days.

---

Issued 03/03/2011
Revised 03/04/2013
<table>
<thead>
<tr>
<th>Substance</th>
<th>Amount (g, KG, ml, L)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium Aluminum Hydride</td>
<td>25g</td>
<td>100</td>
</tr>
<tr>
<td>Hexane</td>
<td>4L</td>
<td>50</td>
</tr>
<tr>
<td>Acetone</td>
<td>1L</td>
<td>12.5</td>
</tr>
<tr>
<td>Methanol</td>
<td>2L</td>
<td>25</td>
</tr>
<tr>
<td>Ether</td>
<td>1L</td>
<td>12.5</td>
</tr>
<tr>
<td>Salicylic Acid</td>
<td>40g</td>
<td>----</td>
</tr>
<tr>
<td>Acetanilide</td>
<td>12g</td>
<td>----</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>100ml</td>
<td>1</td>
</tr>
<tr>
<td>Acetone</td>
<td>300ml</td>
<td>5</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>6L</td>
<td>94</td>
</tr>
</tbody>
</table>

Total 100%

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

SECURE TAG TO CONTAINER (NO TAPE)
Safety Evaluation

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

\( S = \text{Satisfactory} \quad N = \text{Needs Improvement} \quad N/A = \text{Not Applicable} \)

### Hazard Communication Act/ General Safety

<table>
<thead>
<tr>
<th>Requirements for regulatory compliance.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The UT Arlington Laboratory Safety Manual is available or easily accessible online.</td>
</tr>
<tr>
<td>2. All lab personnel have completed the online Hazard Communication training.</td>
</tr>
<tr>
<td>3. Hazard Communication Program Site Specific Training is documented and available for review.</td>
</tr>
<tr>
<td>4. MSDS are available or readily accessible for every hazardous chemical present and lab personnel know where and how to obtain MSDS.</td>
</tr>
<tr>
<td>5. All chemicals are stored by hazard class, based on incompatibility, and in accordance with MSDS.</td>
</tr>
<tr>
<td>6. Flammables stored in the lab are minimized and are kept in flammable storage cabinets.</td>
</tr>
<tr>
<td>7. Peroxide forming chemicals are not stored beyond their expiration date.</td>
</tr>
<tr>
<td>8. No corrosive chemical solvents or are stored above eye level (5ft).</td>
</tr>
<tr>
<td>9. Compressed gas cylinders are secured and the safety cap is in place when cylinders are not in use.</td>
</tr>
<tr>
<td>10. Flammable solvents are not stored in household refrigerators.</td>
</tr>
<tr>
<td>11. Refrigerator/freezers labeled either “Food &amp; Drinks Only” or “No Food &amp; Drinks”.</td>
</tr>
<tr>
<td>12. Lab Personnel do not eat, drink, or apply cosmetics in lab.</td>
</tr>
<tr>
<td>13. Secondary containers, other than ones for immediate use, are labeled with the identity of their contents.</td>
</tr>
<tr>
<td>14. No breakable chemical containers are stored on the floor.</td>
</tr>
<tr>
<td>15. All chemical containers are kept closed if not in use.</td>
</tr>
<tr>
<td>16. The labels on incoming chemical containers are not removed or defaced.</td>
</tr>
<tr>
<td>17. Chemicals are dated when received and when opened.</td>
</tr>
<tr>
<td>18. A chemical inventory list is maintained and current.</td>
</tr>
<tr>
<td>19. Spill control materials are available in the lab.</td>
</tr>
</tbody>
</table>

### Chemical Waste

<table>
<thead>
<tr>
<th>Comments/Notes</th>
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</thead>
<tbody>
<tr>
<td>1. Chemical waste compliance poster is posted in the lab where hazardous waste is accumulated.</td>
</tr>
<tr>
<td>2. Chemical waste is located in the immediate vicinity of generation and under supervision of the person who generated it.</td>
</tr>
<tr>
<td>3. All containers are clearly labeled with the contents of the container and the words “hazardous waste”.</td>
</tr>
<tr>
<td>4. Any labels which are incorrect should be defaced.</td>
</tr>
<tr>
<td>5. Each waste container has a properly filled out waste tag attached to it.</td>
</tr>
<tr>
<td>6. If the container contains a reactive, a cancer suspect, or infectious agent, is this noted on the container?</td>
</tr>
<tr>
<td>7. All containers are compatible with their contents.</td>
</tr>
<tr>
<td>8. All containers are closed unless actively receiving waste.</td>
</tr>
<tr>
<td>9. Waste container is properly stored in secondary containment.</td>
</tr>
<tr>
<td>10. No containers are leaking.</td>
</tr>
<tr>
<td>11. No waste is poured down the drain.</td>
</tr>
<tr>
<td>12. Less than a total of 55 gallons of possibly hazardous waste is present. If no: has a CEMS Hazardous Waste Pickup Request been submitted?</td>
</tr>
<tr>
<td>13. Less than a total of one quart of acutely hazardous waste is present.</td>
</tr>
</tbody>
</table>

Revised November 2011
14. For containers that are ready for disposal: has EH&S been contacted for pick-up (CEMS Hazardous Waste Pickup Request submitted)?

<table>
<thead>
<tr>
<th>Special Waste</th>
<th>S</th>
<th>N</th>
<th>N/A</th>
<th>Comments/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All sharps are deposited into red sharps containers provided and picked up by EH&amp;S.</td>
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<td>2. There is no evidence of bent, re-capped, or clipped needles.</td>
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<td>3. Sharp containers are not more than ¾ full.</td>
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<thead>
<tr>
<th>Personal Protective Equipment</th>
<th>S</th>
<th>N</th>
<th>N/A</th>
<th>Comments/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The appropriate personal protective clothing for work being performed is present, in good condition, and used by lab personnel.</td>
<td></td>
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<tr>
<td>2. Occupants do not wear open-toed shoes, sandals, flip-flops, clogs, etc.</td>
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</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Fire/Life Safety</th>
<th>S</th>
<th>N</th>
<th>N/A</th>
<th>Comments/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All exits and walkways in the lab are free of obstructions and tripping hazards.</td>
<td></td>
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<tr>
<td>2. Lab doors are kept closed as much as possible to provide a fire and smoke barrier.</td>
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<tr>
<td>3. The ceiling is intact (i.e., ceiling tiles in place, etc.)</td>
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<tr>
<td>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.</td>
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<tr>
<td>5. The fire extinguisher is unobstructed and has been inspected within the past year.</td>
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<tr>
<td>6. If more than 10 gallons of flammables are being used in the laboratory, are they stored in fire rated storage cabinets?</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Electrical Safety</th>
<th>S</th>
<th>N</th>
<th>N/A</th>
<th>Comments/Notes</th>
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</thead>
<tbody>
<tr>
<td>1. All electrical cords are in good condition. None have exposed wiring, cracked, brittle, or frayed insulation.</td>
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<tr>
<td>2. No electrical cords are run above the ceiling tiles.</td>
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<tr>
<td>3. No extension cords are used. No multi-plug adapters are used. No power strips plugged into other power strips.</td>
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<tr>
<td>4. No electrical cords are run across the floor where they could be a tripping hazard</td>
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<tr>
<td>5. There is clear access to the breaker panel.</td>
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<table>
<thead>
<tr>
<th>Physical Hazards</th>
<th>S</th>
<th>N</th>
<th>N/A</th>
<th>Comments/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All belt driven vacuum pumps are protected with belt guards, properly maintained and stored away from flammable chemicals and combustible material.</td>
<td></td>
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<tr>
<td>2. Glassware used at pressures other than ambient are taped or shielded</td>
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<tr>
<td>3. Broken glassware is deposited into puncture resistant containers which are provided by and picked up by Custodial Services.</td>
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</tbody>
</table>

Inspector Signature: ___________________________ Date: ____/___/___

Reviewer Signature: ___________________________ Date: ____/___/___

Revised November 2011
C. EMPLOYEE SITE-SPECIFIC HAZARD COMMUNICATION TRAINING ("WORK AREA SPECIFIC")

Information specific to the employee’s particular work area must be provided by the employing department. New employees must be trained before being required to work with, or being exposed to, hazardous chemicals. Representatives from EH&S will assist the departmental instructor, if requested, in understanding the general aspects of the Texas Hazard Communication Act (an explanation of Material Safety Data Sheets, labeling, written plan, etc.).

Work Area Specific or Site Specific Hazard Communication Training must include:

1. Information on labeling and MSDS; the relationship between those two methods of hazard communication;
2. Location of and access to MSDS in the workplace during normal and off-shift working hours; and
3. For hazardous chemicals known to be in the employee’s work area(s):
   - the location of hazardous chemicals,
   - safe handling
   - warning signs of overexposures and first aid treatment for exposures
   - physical effects, both short-term (acute) and long-term (chronic) health effects of exposure,
   - proper use and selection of Personal Protective Equipment (PPE), and
   - general instructions on handling, cleanup, and disposal of hazardous chemicals.

Assistance with spill clean up and disposal is available from the EH&S Hazardous Materials Section at ext. 2-2185.

In addition, this employee training may be augmented with educational training programs and materials provided by or available from the Texas Department of State Health Services “Outreach Program.”

Work area specific training must be accomplished prior to an employee being exposed to the hazards of their workplace. This training must include topics detailed in Part V, D and shall be documented on the UTA Hazard Communication Program Site-Specific Training Record (EXHIBIT 3a & 3b). A copy of this form shall be forwarded to the EH&S Office. These records shall be maintained for at least 5 years after an employee separates from the University.
The University requires documentation that all laboratory employees who use or handle chemicals are trained in accordance with the Hazard Communication Act. This requires the completion of both General Hazard Communication training and Site-Specific training, and if applicable, Basic Radiation and Laser Safety. The Lab Supervisor or Principal Investigator (PI) is responsible for ensuring that Site-Specific training is provided to new employees and whenever the potential for exposure to hazardous chemicals increases significantly or when new or significant hazard information is received. In compliance with UTA’s Laboratory Safety Manual, Hazard Communication Program and the Texas Hazard Communication Act, the individuals listed below have attended a training session covering the provisions on the reverse side of this document.

Dept: ___________________ Building/Room: ______________ Date: ___________

P.I.: ___________________ Instructor: ___________________
(Print)                  (Print)

<table>
<thead>
<tr>
<th>Name (print clearly)</th>
<th>Name (print clearly)</th>
<th>UTA EID</th>
<th>Employee Code*</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last, First, MI</td>
<td>PI &amp; Lab</td>
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</table>

*Employee Codes: Faculty (F); Postdoc (P); Graduate Student (G); Undergraduate (U); Research Staff (R); Storeroom Staff (S); Other (O) please specify: ________________________________

I certify that the topics listed on the reverse side were covered in this training session.

_________________________________________________________________________________________ Instructor
Signature Date

Keep a copy for your records (both sides) and return the completed original form to EH&S, Box 19257.
UT Arlington Hazard Communication Program
Site-Specific Training Record

Instructor: ___________________________ ___________________________ ___________________________
(Please print) (Signature) (Date)

Department: ________________________________

☐ General Training ☐ Site-Specific Training

List of Subject(s) Discussed:
☐ Compressed Gas Cylinders Safety/Storage
☐ Chemical Storage/ Chemical Segregation
☐ Cryogenic Safety/Handling
☐ Flammable Liquids Storage Guide/Limits
☐ Glass Cleaning/Disposal
☐ Hazardous Waste Disposal (Handling/ Clean-up/ Storage/Disposal)
☐ Hydrofluoric Acid Safety/Handling/Disposal
☐ Lab Chemical Fume Hoods
☐ Lab Chemical Spills Procedure
☐ Lab Electrical Equipment
☐ Location of Hazardous Chemicals/ Health Effects/ Safe Handling
☐ MSDS Interpretation/ Labeling Interpretation/ How MSDS & Labels Relate
☐ Mercury Handling
☐ Peroxide Forming Compounds
☐ Personal Protective Equipment
☐ Piranha Solution
☐ Pyrophoric Chemical Safety
☐ Toxic Gas

List other safety subject’s specific to the lab:
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