CHEMICAL AND BIOLOGICAL LABORATORY SAFETY

Introduction

The Environmental Health & Safety Office (EH&S) supports The University in its quest to excel in research and teaching. EH&S has prepared a **Laboratory Safety Manual** to promote safe practices in laboratories and to provide information to faculty, researchers, and students to assist them in meeting their goals.

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

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

Because laboratories involve numerous chemicals, procedures, and operations, they require extensive safety precautions. Laboratory safety involves chemical safety, fire safety, electrical safety, and other safety issues.

All of these subjects are covered in detail in the Laboratory Safety Manual which has been distributed to all laboratories and to all Principal Investigators on this campus. At the end of this section is a Table of Contents listing the subjects covered in this manual. Please contact Environmental Health & Safety, Ext. 2185, if you need a copy. The Laboratory Safety Manual is available on the Environmental Health & Safety web page at http://www.uta.edu/ehsafety/main.htm

LABORATORY SAFETY

This section discusses the following:

- Common laboratory hazards
- Controlling laboratory risks
- Safe laboratory practices
- Equipment safety

Common Laboratory Hazards

Examples of common hazards include the following:

- Chemical hazards:
  - Toxins, corrosives, flammables, and reactives
- Biological hazards:
  - Microbes, animals, plants, and genetically modified agents
- Radiation hazards:
  - Ionizing and nonionizing radiation
- Physical hazards:
  - Heating devices, noise, projectiles, fire, cold, etc.
- Electrical hazards:
  - Fire and shock
- Mechanical hazards:
  - Moving machinery
- Airborne hazardous materials:
  - Vapors, dust, etc.
- Ergonomic factors:
  - Standing, repetitive motion

Controlling Laboratory Risks

Administrative and engineering controls can help minimize laboratory risks. However, safety conscious workers using good laboratory practices are the most important component of laboratory safety. The following factors are important for safe laboratory operations:

- Adequate facilities:
  - Proper ventilation
  - Nonslip surfaces
  - Hand washing facilities
- Available and appropriate safety equipment:
  - Personal protective equipment
  - Laboratory equipment
  - Safety devices on laboratory equipment, machines, devices, and instruments

Appropriate emergency equipment:
- Fire extinguishers
- Emergency showers
- Eye wash stations

Appropriate procedures:
- Good housekeeping
- Personal hygiene (e.g., washing hands)

Knowledgeable workers:
- Experienced
- Trained

All laboratory doors should be labeled with emergency contact information. If an incident occurs during off-hours, respondents need to know the names and telephone numbers of the people responsible for laboratory operations. Keep this information current and accurate. Emergency contact labels are available from the Environmental Health & Safety Office.

Properly trained and experienced workers have the greatest ability to control laboratory risks. By using good laboratory practices, workers can minimize hazards, exposure, contamination, and workplace accidents.

Safe Laboratory Practices

To ensure laboratory safety, follow safe laboratory practices, including the following:

- Know about the chemicals and hazards associated with your laboratory.
- Know what to do in different emergency situations.
- Know how to read and interpret MSDS.
- Wear personal protective equipment, as appropriate.
- Follow safe practices for working with chemicals. (Refer to the Chemical Safety chapter for more information.)
- Ice from a laboratory ice machine should not be used for human consumption.
- Dedicate microwave ovens and other heating devices exclusively for food or for laboratory operations. Ensure that ovens are clearly labeled to indicate their function.
- Do not wear contact lenses around chemicals, fumes, dust particles, or other hazardous materials.
- Protect unattended operations from utility failures and other potential problems that could lead to overheating or other hazardous events.
- Avoid working alone in a laboratory.
- Avoid producing aerosols.
- Use extreme care when working with needles, blades, and glass.
- Do not eat, drink, or use tobacco products in the laboratory.
- Do not mouth pipet.
- Clean contaminated equipment and spills immediately. Avoid contaminating equipment with mercury. Clean mercury spills immediately. (Chronic exposure to mercury can result from

a few drops left uncleaned.)
Do not allow children in the laboratory. (It is a violation of state law for a child to be unattended in a place that presents a risk of harm.)
Keep laboratory doors closed.
Decontaminate all affected equipment.
Avoid using dry ice in enclosed areas. (Dry ice can produce elevated carbon dioxide levels.)
Dry ice mixed with isopropanol or ethanol may cause frost bite.
Hallways, corridors, and exit ways must be kept clear. Do not locate (even temporarily) laboratory equipment or supplies in these areas.

IMPORTANT:
Never underestimate the hazards associated with a laboratory. If you are unsure about what you are doing, get assistance. Do not use unfamiliar chemicals, equipment, or procedures alone.

Equipment Safety
There are four fundamental elements of equipment safety: (1) use the correct equipment, (2) know how to operate the equipment, (3) inspect the equipment, and (4) use the equipment properly.

Use equipment for its intended purpose only. Do not modify or adapt equipment without guidance from the equipment manufacturer or the Environmental Health & Safety Office. Do not defeat, remove, or override equipment safety devices.

Working in a laboratory requires various types of equipment. To ensure equipment safety, you must be familiar with the following:

Equipment operation
Applicable safeguards
Maintenance requirements

Always inspect equipment before using it. Ensure that the equipment meets the following requirements:

Controls and safeguards are adequate and functional.
Location is safe (and well-ventilated, if necessary).
Equipment works properly.

IMPORTANT:
Disconnect any equipment that is unsafe or does not work properly, and remove it from service. Notify other users of the problem.

Refer to the Laboratory Safety Manual for specific information on operating laboratory equipment, such as fume hoods, heating devices, vacuums, etc.

BIOLOGICAL SAFETY

Biosafety Principle
The primary principle of biological safety (i.e., biosafety) is containment. The term containment refers to a series of safe methods for managing infectious agents in the laboratory. The purpose of containment is to reduce or eliminate human and environmental exposure to potentially harmful agents.

Primary and Secondary Containment
There are two levels of biological containment: primary and secondary. Primary containment protects people and the immediate laboratory environment from exposure to infectious agents. Good microbial techniques and safety equipment provide sufficient primary containment. Examples of primary barriers include safety equipment such as biological safety cabinets, enclosed containers, and safety centrifuge cups. Occasionally, when it is impractical to work in biological safety cabinets, personal protective equipment, such as lab coats and gloves may act as the primary barrier between personnel and infectious materials.

Secondary containment protects the environment external to the laboratory from exposure to infectious materials. Good facility design and operational practices provide secondary containment. Examples of secondary barriers include work areas that are separate from public areas, decontamination facilities, handwashing facilities, special ventilation systems, and airlocks.

Elements of Containment
Ultimately, the three key elements of biological containment are laboratory practices, safety equipment, and facility design. To ensure minimal exposure, employees must assess the hazards associated with their work and determine how to apply the biosafety principle appropriately.

IMPORTANT:
Employees working with infectious agents or potentially infectious materials must be aware of the hazards associated with their work. These workers must be trained and proficient in biosafety procedures and techniques.

General Biosafety Guidelines
Biohazardous materials require special safety precautions and procedures.
Follow these guidelines when working with infectious agents:

Personal Hygiene Guidelines:
Wash your hands thoroughly, as indicated below:
- After working with any biohazard
- After removing gloves, laboratory coat, and other contaminated protective clothing
- Before eating, drinking, smoking, or applying cosmetics
- Before leaving the laboratory area

- Do not touch your face when handling biological material
- Never eat, drink, smoke, or apply cosmetics in the work area

Clothing Guidelines:

Always wear a wrap-around gown or scrub suit, gloves, and a surgical mask when working with infectious agents or infected animals.
Wear gloves over gown cuffs.
Never wear contact lenses around infectious agents.
Do not wear potentially contaminated clothing outside the laboratory area.
To remove contaminated clothing, follow these steps:

1. Remove booties from the back.
2. Remove head covering from the peak.
3. Untie gown while wearing gloves.
4. Remove gloves by peeling them from the inside out.
5. Remove the gown by slipping your finger under the sleeve cuff of the gown.

Handling Procedures:

Use mechanical pipetting devices.
Minimize aerosol production.
Add disinfectant to water baths for infectious substances.
Use trunnion cups with screw caps for centrifuging procedures. Inspect the tubes before use.
Use secondary leak-proof containers when transporting samples, cultures, inoculated petri dishes, and other containers of biohazardous materials.

Syringes:

Avoid using syringes and needles whenever possible. If a syringe is necessary, minimize your chances of exposure by following these guidelines:
Use a needle-locking or disposable needle unit.
Take care not to stick yourself with a used needle.
Place used syringes into a pan of disinfectant without removing the needles.
Do not place used syringes in pans containing pipettes or other glassware that require sorting.
Do not recap used needles.
Dispose of needles in an approved sharps container.

Work Area:

Keep laboratory doors shut when experiments are in progress.
Limit access to laboratory areas when experiments involve biohazardous agents.
Ensure that warning signs are posted on laboratory doors. These signs should include the universal biohazard symbol and the approved biosafety level for the laboratory.
Ensure that vacuum lines have a suitable filter trap.
Decontaminate work surfaces daily and after each spill.
Decontaminate all potentially contaminated equipment.

Transport contaminated materials in leak-proof containers.
Keep miscellaneous material (i.e., books, journals, etc.) away from contaminated areas.
Completely decontaminate equipment before having maintenance or repair work done.

Universal Precautions:

Clinical and diagnostic laboratories often handle specimens without full knowledge of the material's diagnosis; these specimens may contain infectious agents. To minimize exposure, observe universal precautions when handling any biological specimen. Consider all specimens to be infectious and treat these materials as potentially hazardous.

CHEMICAL SAFETY

General Safety Guidelines

Almost everyone works with or around chemicals and chemical products every day. Many of these materials have properties that make them hazardous: they can create physical (fire, explosion) and/or health hazards (toxicity, chemical burns). However, there are many ways to work with chemicals which can both reduce the probability of an accident to a negligible level and reduce the consequences to minimum levels should an accident occur. Risk minimization depends on safe practices, appropriate engineering controls for chemical containment, the proper use of personnel protective equipment, the use of the least quantity of material necessary, and substitution of a less hazardous chemical for the more hazardous one. Before beginning an operation, ask "What would happen if . . .?" The answer to this question requires an understanding of the hazards associated with the chemicals, equipment and procedures involved. The hazardous properties of the material and intended use will dictate the precautions to be taken.

Another important distinction is the difference between hazard and risk. The two terms are sometimes used as synonyms. In fact, hazard is a much more complex concept because it includes conditions of use. The hazard presented by a chemical has two components: (1) its inherent capacity to do harm by virtue of its toxicity, flammability, explosiveness, corrosiveness, etc.; and (2) the ease with which the chemical can come into contact with a person or other object of concern. The two components together determine risk (the likelihood or probability that a chemical will cause harm). Thus, an extremely toxic chemical such as strychnine cannot cause poisoning if it is in a sealed container and does not contact the handler. In contrast, a chemical that is not highly toxic can be lethal if a large amount is ingested.

Chemical safety is inherently linked to other safety issues including laboratory procedures, personal protective equipment, electrical safety, fire safety, and hazardous waste disposal. Refer to other chapters in this manual for more information on these topics.

Knowledge + Common Sense + Caution = Chemical Safety

Not all chemicals are considered as hazardous. Examples of nonhazardous chemicals include buffers, sugars, starches, agar, and naturally occurring amino acids.

The following sections provide general guidelines for chemical safety.

Chemical Safety Guidelines

Always follow these guidelines when working with chemicals:

Assume that any unfamiliar chemical is hazardous.
Know all the hazards of the chemicals with which you work. For example, perchloric acid is a corrosive, an oxidizer, and a reactive. Benzene is an irritant that is also flammable, toxic, and carcinogenic.
Consider any mixture to be at least as hazardous as its most hazardous component.
Never use any substance that is not properly labeled.
Follow all chemical safety instructions precisely.
Minimize your exposure to any chemical, regardless of its hazard rating.
Use personal protective equipment, as appropriate.
Use common sense at all times.

The five prudent practices of chemical safety sum up these safety guidelines:

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

Material Safety Data Sheets

Before using any chemical, read the container label and the appropriate Material Safety Data Sheets (MSDS). Container labels and MSDS are good sources of information for chemical safety. They provide the following information:

Hazardous ingredients
Exposure limits
Physical and chemical characteristics, including the following:
- Boiling point
- Vapor pressure

Physical hazards, including the following:
- Flammability
- Explosiveness
- Reactivity

Health hazards, including chemicals that are:
- Toxic
- Carcinogens
- Irritants

First-aid procedures
Proper leak, spill, and disposal techniques
Proper storage and handling procedures
Other special provisions

Safe Handling Guidelines

Employees should treat all chemicals and equipment with caution and respect.
When working with chemicals, remember to do the following:

Remove and use only the amount of chemicals needed for the immediate job at hand.
Properly seal, label, and store chemicals in appropriate containers. Keep the containers clearly marked and in a well-ventilated area.
Check stored chemicals for deterioration and broken containers.
Learn how to dispose of chemicals safely and legally. Follow UTA waste disposal requirements.
Clean up spills and leaks immediately.
Know what to do in an emergency.

Likewise, when working with chemicals, remember the following:

Do not store chemicals near heat or sunlight or near substances which might initiate a dangerous reaction.
Do not transport unprotected chemicals between the work area and other areas. Use a tray, rack, cart or rubber carrier.
Always use a secondary container when transporting hazardous or highly odorous chemicals on an elevator.
Do not pour hazardous chemicals down the sink.
Do not put fellow workers or yourself in danger.

Hygiene and Chemical Safety

Good personal hygiene will help minimize exposure to hazardous chemicals.

When working with chemicals, follow these guidelines:

Wash hands frequently and before leaving the laboratory. Also, wash hands before eating, drinking, smoking, or applying makeup.
Remove contaminated clothing immediately. Do not use the clothing again until it has been properly decontaminated.
Follow any special precautions for the chemicals in use.

In addition, follow these special precautions:

Do not eat, drink, smoke, or apply makeup around chemicals.
Do not wear contact lenses near chemicals, especially corrosives or volatile solvents.
Do not keep food or food containers anywhere near chemicals.
Do not use laboratory equipment to serve or store food or drinks.
Do not sniff or taste chemicals.

HAZARD COMMUNICATIONS PROGRAM

UTA has a written program (UTA Hazard Communication Program) that complies with OSHA standards and the Texas Hazard Communication Act for hazardous chemicals. This program is available from the Environmental Health & Safety Office. It requires the following:

Employee training (including recognition of signs of exposure)
Labeling procedures
MSDS for chemicals at each workplace
Instructions on how to read and interpret MSDS
Chemical inventory reporting procedures
Recordkeeping requirements
Emergency response procedures

Refer to the UTA Hazard Communication Program and other sections in this manual for detailed information on these topics.

An integral part of hazard communication is hazard identification. Everyone who works with hazardous chemicals should know how to read and interpret hazard information. Signs, like the NFPA diamond, alert employees to the known hazards in a particular location.

The following is a detailed explanation of the NFPA hazard classification codes:

Health (Blue):
4 Can cause death or major injury despite medical treatment
3 Can cause serious injury despite medical treatment
2 Can cause injury. Requires prompt medical treatment
1 Can cause irritation if not treated
0 No hazard

Flammability (Red):
4 Very flammable gases or liquids
3 Can ignite at normal temperatures
2 Ignites with moderate heat
1 Ignites with considerable preheating
0 Will not burn

Reactivity (Yellow):
4 Readily detonates or explodes
3 May detonate or explode with strong initiating force or heat under confinement
2 Normally unstable, but will not detonate
1 Normally stable. Unstable at high temperature and pressure.
0 Normally stable and not reactive with water.

Specific Hazard (White):

- Oxidizer - OX
- Acid - ACID
- Alkali - ALK
- Corrosive - COR
- Use No Water - W
- Radioactive - R

HAZARDOUS WASTE DISPOSAL

Hazardous Waste and UTA

Hazardous waste disposal is governed by the EPA and the TNRCC through State and Federal regulations. The purpose of environmentally sound disposal methods is to prevent harm to the water, land, and air.

UTA complies with hazardous waste disposal regulations by means of the Hazardous Waste Management Program.

Permits and Requirements

UTA is classified as a "Small Quantity Generator" of hazardous waste. The University's generator permit applies to all of the UTA campus and ARRI. The Environmental Health & Safety Office will assist any department in determining its hazardous waste disposal needs.

Penalties of Noncompliance

Noncompliance with any hazardous waste regulation may result in substantial fines and penalties for the University. In addition, individual generators may be personally liable. Generators may be cited or fined for numerous types of violations. Violations range from improperly labeling a waste container to intentionally disposing of hazardous waste incorrectly.

Role of the Environmental Health & Safety Office

The Environmental Health &Safety Office administers the Hazardous Waste Management Program at UTA. Compliance with this program is very demanding: it requires full cooperation

by all campus entities. The main focus of this program is chemical waste but it also includes the management of biological waste.

The Environmental Health & Safety Office collects, transports, and stores hazardous waste until it is shipped for final disposal. The Office also maintains permanent records of all disposed waste. Contact the EH&S for more information on hazardous waste disposal.

Definitions

Central Accumulation Area
Area(s) designated by the Environmental Health & Safety Office to be used for the storage of hazardous wastes prior to shipment to permitted disposal facilities.

Improper Disposal
The discharge, deposit, injection, dumping, spilling, or placing of any solid waste or hazardous waste (whether containerized or uncontainerized) into or on any land or water so that such solid waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any water, including ground waters and the sanitary sewer.

Generator
Any person, by site, who produces municipal hazardous waste or industrial solid waste; any person who possesses municipal hazardous waste or industrial solid waste to be shipped to any other person; or any person whose act first causes solid waste to become subject to regulation.

Hazardous Waste
Any solid waste material listed or identified in Title 40 Code of Federal Regulations, Part 261, Subpart C or D or exhibiting the characteristics of ignitability, corrosivity, reactivity, or E.P. toxicity also defined in Part 261. A listing and characteristics of hazardous wastes can be found in the Laboratory Safety Manual.

Mixed Waste
A radioactive waste that is also a hazardous waste.

Solid Waste
Any garbage, refuse, sludge from a waste treatment plant, water treatment plant, or air pollution control facility or other discarded material. Solid waste can be solid, liquid, semi-solid, or contained gaseous material resulting from industrial, municipal, commercial, mining and agricultural operations, and from community and institutional activities.

Waste
Any useless and valueless material that is to be discarded.

Types of Hazardous Waste
An item is considered waste when the owner determines that the material is no longer useful and needs to be discarded. An item is considered to be hazardous waste if it meets one or more of the following characteristics:

A chemical component is listed in the Laboratory Safety Manual.
Mixture contains a listed hazardous waste and a nonhazardous waste.
Material meets the definition of one of the following:
Ignitability (flashpoint < 60o C or supports combustion)
Reactivity (e.g., water reactives, cyanides, explosives, unstable chemicals)
Corrosivity (ph < 4 or > 10)
EP toxicity (e.g., pesticides, heavy metals, poisons)
Material is not excluded from regulations.

Individual departments are responsible for properly identifying the hazardous waste they generate and for following University disposal procedures. Refer to the Laboratory Safety Manual for list of regulated hazardous chemicals.

Containers, Tags, and Collection
Proper containment, tagging, collection and disposal are essential to the success of the Hazardous Waste Program. The Laboratory Safety Manual discusses these procedures in detail.

Filling Containers
Hazardous waste collection containers must be in good condition, must not leak, and must be compatible with their hazardous contents (e.g., do not use metal containers for corrosive waste or plastic containers for organic solvents). All containers must have suitable screw caps or other secure means of closure. When large waste containers (greater than 10 gallons total volume) are warranted, contact the Environmental Health & Safety Office for assistance.

If you are reusing a container to accumulate waste, destroy the original product label. EPA regulations require that waste containers be labeled with the accumulation start date, the identity of the contents, and the words "Hazardous Waste". Use a new label to identify the hazardous waste, do not use the disposal tag for this purpose.

IMPORTANT:
Never overfill hazardous waste containers. Expansion and excess weight can lead to spills, explosion, and extensive environmental exposure.

Hazardous waste containers for liquids are generally rated by volume capacity. Allow extra room in liquid containers to allow for contents expansion.
Do not fill jugs and bottles past the shoulder of the container. The shoulder of the container is the place where the container slopes in towards the neck.

Fill closed head cans (5 gallons or less) to leave approximately two inches of space between the liquid level and the top of the container.
Fill closed head drums (larger than 5 gallons) to leave approximately four inches of space.

Hazardous waste containers for solids are generally rated by their weight capacity and volume capacity. Take care not to exceed the weight capacity of a solid container. Weight is generally not a problem for jars and open head cans (5 gallons or less), but it can be a problem for open head drums (larger than 5 gallons). Depending on weight requirements, you may fill containers for solids within two inches of the closure.

IMPORTANT:
Keep all waste collection containers closed except when adding or removing material.

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