LAB

SAFETY

MANUAL

OFFICE OF
ENVIRONMENTAL HEALTH AND SAFETY
HAZARDOUS MATERIALS DIVISION
THE UNIVERSITY OF TEXAS AT AUSTIN

NOVEMBER 1996

Laboratory Safety Manual

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OFFICE OF ENVIRONMENTAL HEALTH AND SAFETY

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Note To Users Of This
Laboratory Safety Manual

The Office of Environmental Health and Safety (OEHS) Hazardous Materials Division has prepared this manual to ensure safe practices in laboratories. The health and safety policy of The University is to take every reasonable precaution to protect the health and safety of faculty, staff, students, and the public. Mandatory safety standards, as interpreted by the requirements and policies stated in this manual and its supplements apply to faculty, staff, researchers, and students engaged in laboratory operations utilizing chemical products and in performing common laboratory procedures.

This manual includes information concerning safe laboratory practices, the use of personal protective equipment, emergency procedures, use and storage of chemicals, and the proper methods of waste disposal. This manual covers safety practices for labs in the biological sciences, incorporating a full description of the various biosafety levels and procedures unique to each. This manual also covers hazard communication and incident response. This information is intended to help those in the laboratory to minimize hazards to themselves and their colleagues.

In view of the wide variety of chemical products handled in laboratories, it should not be assumed that the precautions and requirements stated in this manual are all-inclusive. Faculty, researchers, and students are expected to learn about the hazards of chemical products before handling them. It is expected that the local departmental Chemical Hygiene Officers and Principal Investigators will append to this manual any supplementary information pertinent to their specific areas.

Throughout this manual the terms “employee”, “laboratory worker”, and “laboratory personnel” are used interchangeably and are intended to include students working in a laboratory, unless the context indicates otherwise.

Please contact the OEHS Hazardous Materials Division at 471-3511 for more information or for assistance.

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A. Responsibilities

Each individual conducting chemical reactions, using chemical materials, or performing laboratory procedures is required to have proper training in the safe handling and disposal of all materials he or she uses. Each is responsible for conducting activities in a manner that will not endanger himself or herself and each must comply with the applicable requirements of state and federal law as well as with University policies and procedures described in this manual. Oversight responsibility for ensuring that laboratory activities involving hazardous chemicals conform to prescribed standards is assigned as follows:

UNIVERSITY-WIDE SAFETY RESPONSIBILITIES

The President of The University has ultimate responsibility for safety within the institution.

Office of Environmental Health and Safety

- Provide training to laboratory supervisory personnel.
- Conduct periodic and unannounced laboratory inspections to assure compliance with federal, state and local regulations, as well as the policies and procedures contained in this manual and those contained in any supplementary information developed in the college in response to specific activities or areas of research.
- Undertake necessary enforcement actions to insure full compliance with all institutional safety policies, up to and including independent authority to shut down laboratories for violations of these policies. Approval of the Dean is not required.
- Provide hazardous waste disposal services.
- Provide hazardous material spill response services. The Emergency Response Team is available on campus during normal business hours and responds to after-hours spill emergencies on a call back basis.
- Review laboratory construction, modification and renovation plans safety design.
- Conduct fume hood survey and testing.
- Perform exposure monitoring upon request to determine if the permissible exposure limit or action level has been exceeded. Notification shall be provided to laboratory supervisor.
- Provide guidance for maintaining compliance with federal, state, and local regulations, as well as the procedures stated in this manual
- Conduct laboratory safety evaluations when requested by laboratory supervisors or department chairs.
- Provide assistance in obtaining personal protective equipment.
- Maintain copies of medical consultations and examinations for possible exposures from hazardous chemicals.

Physical Plant and Utilities

- Maintain facilities and facility-related safety systems to assure continuous operation of laboratories

COLLEGE SAFETY RESPONSIBILITIES

Dean

- Has the responsibility to insure the safe operation of all laboratories and other sites in the college where chemicals are used or laboratory procedures are conducted.
- Will insure compliance with the policies and procedures contained in this manual and those contained in any supplementary information developed in the college in response to specific activities or areas of research.
- Has independent enforcement authority to close a laboratory for safety violations. Approval of the Director of OEHS is not required.
- Appoint and delegate appropriate enforcement authority, if appropriate, to a College-wide Chemical Hygiene Officer (CHO) and/or authorize individual Department Chairs and Directors to appoint and delegate appropriate enforcement authority to Departmental Chemical Hygiene Officers. The Dean will maintain a current roster of all CHOs and provide the names of these individuals to OEHS.

Department Chairs and Directors

- Oversee chemical and biological hygiene within departmental laboratories by ensuring that supervisory personnel reporting to them assume their responsibilities for adhering to all safety policies, regulations and procedures.
- Complete and update annual inventories of hazardous chemicals as required by the Texas Hazard Communication Act and The University's Hazard Communication Program (see Appendix XV).
- If authorized by the dean, appoint and transfer appropriate enforcement authority to a Departmental Chemical Hygiene Officer (CHO). The Department Chair or Director assumes all the responsibilities of the CHO when there is not a specified Chemical Hygiene Officer.

Chemical Hygiene Officer

- Advise the Dean, Department Chair, or Director on matters of chemical safety policies and practices.
- Work with employees to develop and implement the chemical hygiene policies and practices outlined in this manual and those contained in any supplementary information developed in the college in response to specific activities or areas of research.
- Monitor compliance with policies and procedures for the procurement, safe use, and proper disposal of chemicals.
- Investigate and retain records of accidents involving hazardous materials.
- Conduct information and general training sessions.
- Maintain a resource file of references and publications on safety matters.

- Assist laboratory supervisors and Principal Investigators in writing Standard Operating Procedures (SOPs) pertinent to their needs.
- Ensure that action is taken to correct laboratory practices and conditions that may result in the release of hazardous materials.
- Ensure that action is taken to correct laboratory practices and conditions identified as unacceptable on laboratory safety self evaluations and safety inspections.

Principal Investigators and Laboratory Supervisors

- Design and conduct laboratory processes and operations to assure that employee exposure to risk conforms to the policies, procedures and objectives contained in this manual and those contained in any supplementary information developed in the college in response to specific activities or areas of research.
- Monitor the procurement, safe use, and proper disposal of chemicals.
- Write Standard Operating Procedures and other information relevant to lab processes in their specific areas as needed to supplement those contained in this manual.
- Instruct employees on the contents of this manual, its appendices, and any supplements, and the location of the manual and related materials within the workplace.
- Take all reasonable precautions to protect the safety and health of laboratory workers and the environment.
- Schedule services for hazardous waste disposal and oversee the handling of hazardous waste pending proper disposal.
- Conduct regular laboratory safety self evaluations.
- Complete and update annual laboratory chemical inventories in accord with the instructions and schedule provided by the Office of Environmental Health and Safety
- Maintain and post a laboratory inventory sign outside of each work area. (See Appendix III, Hazardous Chemical Inventory Instruction Sheet.)
- Inform employees of the permissible exposure limits for the hazardous chemicals listed on inventories and the signs and symptoms associated with exposures to these chemicals.
- Provide site specific training on laboratory hazards as described in The University's Hazard Communication Program (see Appendix XV).
- Obtain pre-approval from the Departmental CHO and provide training and documentation for special procedures, activities or operations.
- Determine the required levels of personal protective equipment, fire extinguishers, fume hoods, flammable liquid storage cabinets, biological safety cabinets, eye washes, safety showers, and spill cleanup kits. Assure that all required equipment is available and in working order and that appropriate training for each item has been provided.
- Have readily available a current copy of a Material Safety Data Sheet for all hazardous chemicals in the laboratory.
- Post emergency telephone numbers on the outside of each laboratory door and by all telephones in the area.

- Report to OEHS if there is reason to believe that exposure levels for a hazardous chemical exceed the action level or the permissible exposure limits and document the incident.
- Forward documentation on laboratory accidents and exposures to OEHS.
- Provide for the safety of visitors.

Employees

- Maintain a thorough understanding of and follow the laboratory policies and procedures in this manual and those contained in any supplementary information developed in the college in response to specific activities or areas of research for all processes using chemical materials.
- Use and maintain personal protective equipment (i.e. lab coats, chemical splash goggles, face shields, respiratory protection, and gloves) as mandated in this manual for laboratories.
- Use flammable liquid storage cabinets, acid storage cabinets, biological safety cabinets, fume hoods, and other laboratory safety equipment provided.
- Inform supervisor immediately of any laboratory safety equipment that is needed but not available or that is not in good working order .
- Inform supervisor immediately of exposure symptoms, accidents, or chemical releases and document incident.
- Attend Hazard Communication Act and all other applicable training sessions.

The University of Texas at Austin
Chemical Hygiene Officer

College/Department Name: _____

Chemical Hygiene Officer (CHO) Name: _____

CHO Address: Building: _____ **Room:**_____

Phone Number:_____ **Campus Mail Code:** _____

Each college and/or department and organized research unit that has laboratories using hazardous chemicals and/or biological agents must designate a Chemical Hygiene Officer (CHO) to carry out the duties and responsibilities of the CHO described in the Laboratory Safety Manual.

The individual identified above has been appointed CHO and has accepted the responsibilities and duties associated with this appointment.

Appointing official:	Chemical Hygiene Officer:
_____	_____
Dean, Department Chair, or ORU Director	Signature
_____	_____
Date	Date

A copy of this form shall be:

placed in the appropriate LABORATORY SAFETY MANUALS,

retained in the Dean's Office and by the Department Chair or ORU Director, and

submitted to the Office of Environmental Health and Safety, Hazardous Materials Division, C2600.

B. Emergency Procedures

All accidents, hazardous materials spills or other dangerous incidents should be reported. A list of telephone numbers must be posted near entrances to each laboratory and storeroom and beside every telephone in the labs. Telephone numbers must include the Principal Investigator (or Laboratory Supervisor), Emergency Medical Services (generally 9-911), UT Police Department (911 or 1-4441), and the Office of Environmental Health and Safety (OEHS) Hazardous Materials Division (1-3511). Callers should explain any emergency situation clearly, calmly, and in detail.

1. Primary Emergency Procedures for Fires, Spills and Accidents:

1. In the event of a fire, pull the nearest fire alarm. If you are unable to control or extinguish a fire, follow the building evacuation procedures.
2. Attend to any person(s) who may have been contaminated and/or injured if it is safe to reach them. Use safety showers and eyewashes as appropriate. In the case of eye contact, promptly flush eyes with water for a minimum 15-minute period and seek medical attention immediately. For ingestion cases, contact the Poison Control Center at 1-800-POISON1. In case of skin contact, promptly flush the affected area with water and remove any contaminated clothing or jewelry. If symptoms persist after washing, seek medical attention.
3. Notify persons in the immediate area about the spill, evacuating all non-essential personnel from the spill area and adjoining areas that may be impacted by vapors or a potential fire.
4. If the spilled material is flammable, turn off all potential ignition sources. Avoid breathing vapors of the spilled materials. Be aware that some materials either have no odors or create olfactory fatigue, so that you stop smelling the odor very quickly.
5. Leave on or establish exhaust ventilation if it is safe to do so. Close doors to slow down the spread of odors.
6. Notify the OEHS Hazardous Materials Division (1-3511).

If there is an immediate threat to life or health:

Call City of Austin Emergency Services at 9-911 (campus phone) for assistance with injured, in case of fire, or for performing rescues. Give the nature and the extent of the emergency; be as specific and detailed as possible. An ambulance, fire truck, or police vehicle will respond upon your request.

Notify the UT Police Department (911 on campus) if you have dispatched any City of Austin Emergency Services that will be entering the campus.

If the spill is minor:

7. Use a spill control kit appropriate to control material spilled, if appropriately trained to respond.
8. If the spill is minor and of known limited danger, clean up immediately. Determine the appropriate cleaning method by referring to the MSDS. During cleanup, wear *appropriate* protective apparel. The protective clothing required will depend upon the material spilled, the amount, and the airborne concentration. At a minimum, chemical resistant gloves and goggles should be worn.
9. Cover liquid spills with compatible absorbent material such as spill pillows or a kitty litter/vermiculite mix. Be sure to check compatibility. Powdered materials should be covered with wet paper towels (if compatible) to avoid dispersal. If appropriate materials are available, corrosives should be neutralized prior to absorption. Clean spills from the outer areas first, cleaning towards the center.
10. Place the spilled material into an impervious container, seal, and contact OEHS for disposal.
11. If appropriate, wash the affected surface with soap and water. Mop up the residues and containerize for disposal.
12. A solvent, e.g. xylene, may be necessary to clean surfaces contaminated with a non-water soluble chemical. Be sure to check the solubility of the spilled material and use the least toxic effective solvent available. Be sure to wear appropriate protective equipment.

Supplies and equipment must be assembled and kept on hand to deal with any potential spill. The extent to which spill equipment is available depends on the chemicals, the process, and the personnel working in the lab. Assistance in assembling chemical spill control kits is available from the OEHS, Hazardous Materials Division, at 1-3511.

2. Special Procedures for Radioactive Hazards

(In addition to these guidelines, refer to The University's Radiation Safety Manual.)

1. Do not take any action unless you have been trained to respond, except to summon assistance.
2. If it is safe to do so, attend to anyone who may have been contaminated and/or injured. Use safety showers and eyewashes as appropriate. Notify OEHS Radiation Safety Section (1-3511) and obtain appropriate radiation meters and assistance. Call City of Austin Emergency Services at 9-911 (on campus) for assistance with injured, in case of fire, or for performing rescues. Describe the nature and the extent of the emergency; be as specific and detailed as possible. An ambulance, fire truck, or police vehicle will respond upon your request.
3. Notify the UT Police Department (911 on campus) if you have dispatched any City of Austin Emergency Services that will be entering campus.

4. Remove all personnel from the immediate spill area to a safe meeting location in or near the lab.
5. Shut off ventilation, close windows and doors, and turn off hoods if possible. Do not do this if radioactive gas is involved, as release to the environment is preferable in that case.
6. With the assistance of the OEHS Radiation Safety Section, check all personnel for skin and clothing contamination.
7. Under the guidance of the OEHS Radiation Safety Section, decontaminate personnel and re-survey until radiation levels are at background.

3. Special Procedures For Biological Hazards

1. Do not take any action unless you have been trained to respond, except to summon assistance.
2. Attend to anyone who may have been contaminated and/or injured if it is safe to reach them. Use safety showers and eyewashes as appropriate. Call City of Austin Emergency Services at 9-911 (on campus) for assistance with injured, in case of fire, or for performing rescues. Describe the nature and the extent of the emergency; be as specific and detailed as possible. An ambulance, fire truck, or police vehicle will respond upon your request.
3. Notify the UT Police Department (911 on campus) if you have dispatched any City of Austin Emergency Services that will be entering campus.
4. If the room is equipped with ultraviolet lights, turn them on.
5. Notify persons in the immediate area about the spill. Evacuate non-essential personnel from the spill area.
6. Leave the laboratory and close all doors to prevent re-entry.
6. Notify the OEHS Hazardous Materials Division (1-3511).
8. If your clothing is contaminated, remove it and place it in a properly labeled impervious container. Avoid close contact with other people to prevent additional exposures. Take a shower.
9. Put on protective clothing and equipment.
10. Wait at least 30 minutes for the aerosol to settle before entering the contaminated room. Turn off ultraviolet lights and check for visible mists in the air before entering.
11. Apply appropriate disinfectant to the spill with a gentle flooding action to avoid secondary aerosols. Allow sufficient contact times.
12. Cover excess liquids with absorbent material. Dry material should be covered with wet paper towels to avoid dispersal.

13. Place the spill clean-up material into a container and autoclave it or call OEHS for disposal.
14. Wash the affected surface with strong disinfectant.
15. For a spill in a biological safety cabinet: clean immediately, keep the cabinet running, and use a chemical disinfectant such as bleach or alcohol and paper towels.
16. For a minimally hazardous material without aerosol, and in small volume: clean with paper towel soaked in a disinfectant.

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

4. Building Evacuation Procedures

1. Building evacuation may be necessary if there is a chemical release, fire, explosion, natural disaster, or medical emergency.
2. Be aware of the marked exits from your area and building.
3. The evacuation alarm is a loud continuous siren or horn.
4. To activate the building alarm system, pull the handle on one of the red boxes located in the hallway. If there is a fire, call Austin Fire Department at 9-911, give your name, and describe the exact location (building name, building location, and room number) and size of the fire, then call UTPD at 911.
5. *Whenever* the building evacuation alarm is sounded or when you are ordered to leave by the UTPD, OEHS, or emergency response personnel, *walk quickly to the nearest marked exit* and ask others to do the same.
6. Outside, proceed to a clear reassembly area that is at least 150 feet from the affected building. Keep walkways clear for emergency vehicles.
7. To the best of your ability and without reentering the building, be available to assist UTPD and OEHS in their attempts to determine that everyone has been evacuated safely.
8. An Emergency Command Post will be set up near the emergency site by the emergency responders. Keep clear of the post unless you have important information to report.
9. Do not return to the building until you are told to do so by the UTPD, OEHS, or City of Austin responders.

(Also refer to Appendix VI for Emergency Procedures poster.)

C. Fundamentals of Laboratory Safety

1. Procurement, Distribution, and Storage

(a) Procurement

Before a substance is received, information on proper handling, storage, and disposal must be known to those who will be involved. Refer to the appropriate MSDS for further information. No container may be accepted into a laboratory without an adequate identifying label. This label cannot be removed, defaced, or damaged in any way. All substances should be received in a central location.

(b) Stockrooms/Storerooms

Toxic substances must be segregated in a well-identified area with local exhaust ventilation. Chemicals which are highly toxic or other chemicals whose containers have been opened must be in unbreakable secondary containers. For example, place containers of concentrated acids or bases into plastic tubs to help contain any leakage. Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity. The labels must be checked to ensure they are still readable. If labels begin to fall off the container, secure them. If a label is becoming unreadable, affix a new label to the container with the identity of the contents, health hazards (including target organs, and manufacturer).

(c) Distribution

When chemicals are hand carried, place the container in an outside (secondary) container or bucket. Container carriers for breakable containers such as glass can be purchased through a variety of safety catalogues. They can also be purchased at the Research Storeroom in Welch Hall. These secondary containers provide protection to the bottle and help keep it from breaking. They also help to minimize spillage if the bottle does break. Freight-only elevators are to be used when transporting chemicals.

(d) Laboratory Chemical Storage

Read the label carefully before storing a chemical. All chemicals must be stored according to the Chemical Storage Segregation Scheme in Appendix I. Note that this is a simplified scheme and that in some instances chemicals of the same category may be incompatible.

1. Store all chemicals by their hazard class and not in alphabetical order. Storing chemicals by alphabetical order will often result in the placement of incompatible chemicals being next to one another. Only within the segregation groups can chemicals be stored in alphabetical order. If a chemical exhibits more than one hazard, segregate by using the characteristic that exhibits the primary hazard.
2. Do not store chemicals near heat sources such as ovens or steam pipes. Also, do not store chemicals in direct sunlight.
3. Date chemicals when received and first 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 can become unsafe while in storage, e.g., diethyl ether, then an expiration date should also be included. Keep in mind that expiration dates set by the manufacturer do not necessarily imply that the chemical is *safe* to use up to that date.

4. Do not use lab benches as permanent storage for chemicals. In these locations, the chemicals can easily be knocked over, incompatible chemicals can be stored alongside one another, and the chemicals are unprotected in the event of a fire. Each chemical must have a proper designated storage location and be returned there after use.
5. Inspect your chemicals routinely for any signs of deterioration and for the integrity of the label. State law requires that ***all*** chemicals must be clearly labeled. Another benefit of labeling is to prevent chemicals from becoming "unknowns." (See Section C.7, *Signs and Labels*, for more information.)
6. Do not store any chemicals in glass containers on the floor.
7. 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 fumehood, the greater the likelihood of having chemical vapors being drawn back into the room. Some chemical fume hoods have ventilated storage cabinets underneath for storage of frequently used chemicals that require ventilation.
8. Promptly contact the OEHS for the disposal of any old, outdated, or unused chemicals.
9. Chemicals that require refrigeration must be sealed with tight-fitting caps and kept in lab safe refrigerators. Lab safe refrigerators/freezers must be used for cold storage of flammables.
10. Do not store chemicals above eye level. If the container breaks, the contents can fall onto your face and upper body.
11. Do not store excessive amounts of chemicals in the lab. Buying chemicals in large quantities creates a serious fire hazard and limits work space. The disposal costs far exceed any cost savings from large quantity purchasing.

2. Storage Cabinets

Specific types of storage cabinets must be specified in laboratories in order to separate incompatible chemicals from one another and to safely store all chemicals. All chemicals must be stored in a secure container, preferably within enclosed cabinets.

Flammable Storage Cabinets

Flammables not in active use must be stored in safe containers inside fire resistant storage cabinets specially designed to hold them. Flammable storage cabinets must be specified for all labs that use flammable chemicals. The cabinet must meet NFPA 30 & OSHA 1910.106 standards. Flammable storage cabinets are designed to protect the contents from the heat and flames of external fire rather than to confine burning liquids within. They can perform their protective function only if used and maintained properly. Cabinets are generally designed with double-walled construction and doors which are two inches above the base (the cabinet is liquid-proof up to that point).

Acid Storage Cabinets

Acids should be kept in acid storage cabinets specially designed to hold them. Such cabinets have the same construction features of a flammable storage cabinet, but are coated with an epoxy enamel to guard against chemical attack, and use polyethylene trays to collect small spills and provide additional protection from corrosion for the shelves. Periodically check shelves and supports for corrosion. Nitric acid should always be stored by itself or in a separate acid cabinet compartment.

Compressed Gas Cylinder Cabinets

All Compressed gas cylinders having a NFPA Health Hazard Rating of 3 or 4 (e.g. ammonia, chlorine, phosgene) and those with a Health Hazard Rating of 2 but no physiological warning properties (e.g. carbon monoxide) must be kept in a continuously, mechanically ventilated enclosure. (Note: the OEHS Fire Section at 471-3511 can help you determine the Health Hazard Rating of compressed gases.) Full size cylinders can be stored in a gas cylinder cabinet whereby smaller cylinders, e.g., lecture bottles, can be stored in a chemical fumehood, a storage cabinet under the fumehood (if ventilated), or some other ventilated enclosure. Compressed gas cylinder cabinets must meet Article 80 of the Uniform fire Code and the following requirements: negative pressure in relation to the surrounding area with the exhaust from the cabinet going to the outside of the building, self-closing doors, and internally sprinklered or installed in a sprinklered area. Cylinders stored in compressed gas cylinder cabinets or other ventilated enclosures must be secured at all times. When stored in a cabinet or hood, lecture bottles must also be secured.

3. Personal Protective Clothing and Equipment

It is the Principal Investigator and/or Lab Supervisor's responsibility to specify all necessary personal protective clothing for laboratory workers. The University is responsible for providing basic safety equipment such as fire extinguishers. Refer to the Basic Rules and Procedures for Working with Chemicals section of this manual for further information on personal protection requirements.

4. Signs and Labels

Prominent signs and labels of the following types should be used:

- Laboratory Inventory posters, including emergency contacts, must be posted outside each work area (see Appendix III);
- Emergency Instruction signs must be prominently posted (see Appendix VI);
- Identity labels, showing contents of containers and associated hazards. Labels on all incoming chemical containers cannot be removed or defaced (unless the container is empty and ready for disposal). All secondary containers must be labeled with at least the identity of the contents, health hazards (including target organs), and manufacturer name. OEHS Waste Disposal Tags must be used to identify a waste container as "waste;"

- Employee notification posters describing rights under the Texas Hazard Commu-nication Act must be posted as required in The University's Hazard Commu-nication Program. Posters must be a current version, obtainable through OEHS;
- Location signs for safety equipment, first aid equipment, and exits;
- Warning signs at areas or equipment where special or unusual hazards exist;
- Areas where food and beverage consumption and storage are permitted.

5. Records

Maintaining current records of hazardous chemicals assists in implementing proper storage and safety procedures and is necessary for emergency response pre-planning, both by the OEHS and the City of Austin. It is the Lab Supervisor's responsibility to keep an updated hazardous chemical inventory poster on file at the OEHS and to post a current inventory summary sign outside the lab entrance. Lab personnel should also keep usage records of high-risk substances (See Appendix III for the Hazardous Chemical Inventory Instruction Sheet).

Lab supervisors should document and report any lab accident that results in an injury to UTPD and OEHS. An employee injured in a laboratory should complete a First Report of Injury or Illness form (with the assistance of his or her supervisor). These forms are available from the Office of Human Resources. Any medical records associated with a person's exposure to hazardous materials will be maintained by The University in accordance with state and federal regulations. OEHS will also keep records whenever monitoring of hazardous materials is performed.

Material Safety Data Sheets (MSDS) provide information on hazardous chemicals and must be readily available for all hazardous chemicals in the lab. Some MSDS are available on the mainframe computer and at the OEHS (see Appendix IV).

6. Medical Program

(a) Procedures for Authorizing Medical Treatment

It is the responsibility of every Lab Supervisor to promptly contact OEHS, Hazardous Materials Division, when a suspected exposure to hazardous materials has occurred. The Lab Supervisor will provide details of exposure, including identity of the material, description of the conditions under which exposure occurred, description of signs and symptoms of the exposure, and MSDS, if available. The OEHS will make an assessment to determine if there is sufficient reason to suspect that a potentially significant exposure has occurred. In the event of immediate need, medical attention should be sought prior to notification of OEHS. When the need is not immediate, the OEHS will notify in writing any employees who may have had a potential exposure to hazardous materials. This notification will request that individuals involved obtain a qualified medical examination or consultation.

A medical examination or consultation for lab personnel will be made available by The University under the following circumstances:

- Whenever a lab employee develops signs or symptoms associated with a hazardous chemical to which that person may have been exposed in the laboratory;
- Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance will be established for the affected personnel as prescribed by the particular standard;
- Whenever an event takes place in the work area such as a spill, leak, explosion, or other occurrence resulting in the likelihood of a hazardous exposure, the affected personnel will be provided an opportunity for a medical consultation. The consultation will determine if there is a need for a medical exam.

All medical exams and consultations described under this Medical Program section will be performed by or under the direct supervision of a licensed physician and will be provided at The University's expense, without loss of pay and at a reasonable time and place. The arrangements for a medical consultation or exam should be made with the assistance of OEHS, unless it is an emergency. The OEHS will provide details of the exposure (identity of the hazardous material, description of the conditions under which the exposure occurred, description of signs and symptoms of exposure, and the applicable MSDS) and any other relevant information to the health care provider. In the event of a medical emergency, the person involved should seek medical attention either by dialing 9-911, going to the Student Health Center, or by going directly to Brackenridge, Seton, St. David's, or South Austin Hospital.

(b) Physician's Written Opinion

If a medical consultation or exam is performed, OEHS will obtain a written opinion from the examining physician which includes the following information:

- Any recommendation for further medical follow-up;
- The results of the medical examination and any associated tests;
- Any medical condition which may be revealed in the course of the examination which may place the lab person at increased risk as a result of exposure to a hazardous chemical found in the lab; and
- A statement that the lab person has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

The written opinion cannot reveal specific findings of diagnoses unrelated to occupational exposure.

(c) First aid

During the school day, the Student Health Center (SHC) on Main Campus is available for routine care for students who are injured or ill. The SHC also provides service for limited hours in the evenings and on weekends. During these times, an after-hours fee is charged. If care is needed that the SHC cannot provide or when the SHC is closed, or for non-student lab personnel, Brackenridge, Seton, and St. David's Hospitals are in close proximity to The University. South Austin Hospital is equipped to handle large scale or unknown identify hazardous chemical exposures.

7. Information and Training Program

The University requires that all individuals that work in a laboratory are adequately informed about the physical and health hazards present in the laboratory, the known risks, and what to do if an accident occurs.

Every laboratory worker must be trained to know the location and proper use of available personal protective clothing and equipment. Refer to the "Basic Rules and Procedures for Working with Chemicals" section of this manual for information on the use of personal protective clothing and equipment. The laboratory supervisor is responsible for providing information to his or her personnel about any hazards present in the lab. This information must be provided at the time of a lab person's initial assignment and prior to any assignments involving new potential chemical exposure situations. The following lists the information that should be provided by the lab supervisor:

- The location and availability of this manual;

- Work area specific training for all new personnel as described in The University's written Hazard Communication Program;
- The OSHA Occupational Exposure to Hazardous Chemicals in Laboratories standard (refer to Appendix VII);
- The location and availability of known reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets (MSDS) received from the chemical supplier;
- The permissible exposure limits (PEL) for OSHA regulated substances or recommended exposure limits (for example, TLV) for other hazardous chemicals where there is no applicable OSHA standard (see Appendix VIII for OSHA Permissible Exposure Limits of some common laboratory chemicals). Other significant values may be found on the appropriate MSDS;
- Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory;
- Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by OEHS, continuous monitoring devices, and visual appearance or odor of hazardous chemicals when being released);
- The physical and health hazards of chemicals in the work area;
- The measures lab personnel can take to protect themselves from these hazards, including specific procedures the lab supervisor and/or the OEHS have implemented to protect personnel from exposures to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used; and
- The applicable details of this manual.

Employees must be re-trained when new chemical hazards are introduced into their workplace, or when new hazards are shown on updated Material Safety Data Sheets (MSDS), as well as upon reassignment to different workplaces that involve new chemical hazards or protective measures. Site specific training must be conducted by the lab supervisor.

In addition to the site specific training that is the responsibility of each Lab Supervisor, the following hazardous materials training is offered by the OEHS and is required for graduate students, staff, and faculty that engage in laboratory activities:

(a) Hazard Communication Act Training

Hazard Communication Act training is required for all employees of The University, including faculty, staff, and students who have the potential for exposure to hazardous chemicals. Any work in a laboratory using hazardous chemicals meets the definition of the requirement. OEHS offers this training on a regular schedule and can arrange special sessions with advance notice. Training is required before the employee can be assigned work in or around hazardous chemicals, but annual refreshers are not required. The training takes approximately one hour and includes:

- central requirements of the act, including training, chemical labels, and Material Safety Data Sheets (MSDS);
- spill clean-up and chemical disposal procedures;
- chemical storage guidelines; and
- hazards specific to different chemical groups.

(b) Laboratory Safety Training

Laboratory safety training is required for all employees of The University, including faculty, staff, and students who may work in a laboratory using hazardous chemicals or biological materials. This training must be received prior to or within 30 days after the beginning of a laboratory assignment. OEHS offers this training on a regular schedule and can arrange special sessions with advance notice. The training takes approximately two hours and includes:

- safety equipment and practices;
- emergency procedures;
- emergency equipment; and
- waste disposal.

(c) Fire Extinguisher Training

Fire extinguisher training, with live fire suppression, is required for all laboratory workers. This training covers what to do in the event of a fire, the behavior of fire and how it spreads, the classes of fires, and the proper selection and use of a fire extinguisher. This training program will familiarize laboratory workers with the general principles of fire extinguisher use; give them confidence in their ability to operate the extinguisher; and remove some of the fear associated with putting out a fire by showing them that fire extinguishers do work in putting out fires.

(d) Waste Management Training

Waste management training is required for selected employees of The University, including faculty, staff, and graduate students who are in laboratory supervisory positions where hazardous chemicals or biological materials are in use. Principal Investigators must choose a minimum of one individual for every eight paid members of the PIs group to attend this training. In other words if a PI has from 0 -8 graduate students, post-docs, or staff members then at least one must be chosen to receive training, if there are 9-16 members then at least two must receive training, and so on. Additionally, all staff members that have any supervisory or coordination responsibilities for teaching labs must receive this training. Every teaching lab must have one or more individuals that have received this training and are responsible for following the procedures included in the training. OEHS offers this

training on a regular schedule and can arrange special sessions with advance notice. The training takes approximately two hours and includes:

- hazardous waste definitions and regulatory environment;
- spill clean-up and chemical waste disposal procedures;
- chemical waste storage and segregation guidelines; and
- waste minimization and drain disposal.

(e) Bloodborne Pathogens and Biosafety Training

Bloodborne pathogens and biosafety training is required for selected employees of The University, including faculty, staff, and graduate students who work in laboratories where infectious agents or human blood are in use. OEHS offers this training on a regular schedule and can arrange special sessions with advance notice. The training takes less than two hours and may include, as appropriate to the attendees:

- definition of a bloodborne pathogen;
- universal precautions;
- spill clean-up; and
- practices and equipment required for work at different biosafety levels.

8. Chemical Waste Disposal Program

Chemical wastes are regulated by the Environmental Protection Agency under the Resource Conservation and Recovery Act and its amendments. Laboratory Supervisors are responsible for advising laboratory workers on how to handle *all* wastes generated in laboratory operations.

(a) Chemical Waste Containers

Containers used for the accumulation of hazardous waste must be in good condition, free of leaks, and compatible with the waste being stored in them. A waste accumulation container should be opened only when it is necessary to add waste, and should otherwise be capped. Hazardous waste must not be placed in unwashed containers that previously held an incompatible material (see chart in Appendix IX for examples of incompatible chemicals).

If a container holding hazardous waste is not in good condition or if it begins to leak, transfer the waste from this container into a container that is in good condition, pack the container in a larger and non-leaking container, or manage the waste in some other way that prevents the potential for a release or contamination. Contact OEHS Hazardous Materials Division at 471-3511 if assistance is required.

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

All waste containers:

- Must be marked with the words "waste" or "spent" and their contents indicated. **No** container should be marked with the words "hazardous" or "non-hazardous." OEHS waste disposal tags may be used to list the contents. Paint over or remove any old labels.
- Must be kept at or near (immediate vicinity) the site of generation and under control of the generator.
- Must be compatible with contents (i.e. acid should not be stored in metal cans).
- Must be closed at all times except when actively receiving waste.
- Must be properly identified with completed waste tags before pickup is requested.
- Must be safe for transport with non-leaking screw-on caps.
- Must be filled to a safe level (not beyond the bottom of the neck of the container or a 2-inch head space for 55 gallon drums).

Note: Do not use RED BAGS or SHARPS CONTAINERS (Biohazard) for hazardous chemical waste collection.

(b) Accumulation of Chemical Waste

A generator of potentially hazardous waste may accumulate up to a total of 55 gallons of waste, which may be determined to be hazardous by the Office of Environmental Health and Safety, or one quart of acutely hazardous waste (see Appendix X for list of acutely hazardous waste) at or near the point of generation. If a process will generate more than this volume at one time, OEHS must be contacted in advance to arrange a special waste pick up. Hazardous waste in excess of 55 gallons CAN NOT be stored at your site for more than three days, therefore the OEHS requires advance notice of generation in order to determine if the waste meets the definition of hazardous and to arrange for prompt removal.

It is essential that the generator keep different hazardous wastes separate so that disposal options remain clearer and more cost effective (refer to OEHS Procedures for Disposal of Hazardous Waste Manual). In all cases, do not mix incompatible wastes or other materials in the same container or place wastes in an unwashed container that previously held an incompatible waste or material.

(c) Labeling Containers for Pick Up by OEHS

Before chemical waste can be picked up by OEHS, a waste tag (refer to OEHS Procedures for

Disposal of Hazardous Waste Manual) is required. It should be filled out by the waste generator and attached to each container. The information on the tag is used to categorize and treat the waste. Please fill it out legibly, accurately, and completely.

(d) Submitting Requests for Disposal of Chemical Waste to OEHS

When a chemical waste container is ready for disposal and is properly tagged, the laboratory supervisor should contact the Hazardous Materials Division of the Office of Environmental Health & Safety. (Refer to OEHS Procedures for Disposal of Hazardous Waste Manual for an outline of the Request for Disposal protocol and examples of both a Chemical Waste and a Biological Waste or Sharps Request for Disposal form).

9. Inspections

OEHS inspects all labs at the Main Campus, the Pickle Research Campus, the Marine Science Institute, and other outlying locations on a regular basis. Labs are also expected to perform laboratory safety self evaluations within the first sixty days of each semester. A copy of the self evaluation must be sent to OEHS upon completion. (See Appendix II for Laboratory Safety Self Evaluation Form). *If a lab is not in compliance with the safe operating procedures as outlined in this manual, OEHS has the authority to close the lab until violations are corrected. Approval of the Dean is not required.*

10. Consequences of Non-Compliance

Employees of The University are responsible for ensuring that they follow the procedures and faithfully implement the policies and appropriate responsibilities stated in this Manual. Failure to do so is a serious breach of University policy and subject to disciplinary action that might include termination of employment at The University.

References:

CRC Handbook of Laboratory Safety, Third Edition. A. K. Furr, Ed. Chemical Rubber Company. 1990. (704 page reference on all aspects of lab safety.)

Employee Training Guide, Texas Hazard Communication Act. Texas Department of Health.

Safe Storage and Handling of Laboratory Chemicals - A Review of Safe Storage and Handling Practices for Laboratory Chemicals. Nancy Magnussen. Texas A&M University Chemistry Safety Coordinator.

Texas A&M University Hazard Communication Handbook. Texas A&M University Safety and Health Office. Jan. 1986.

D. Basic Rules and Procedures for Working with Chemicals

1. General Rules

(a) Laboratory Protocol

Everyone in the lab is responsible for his or her own safety and for the safety of others. Before starting any work in the lab, make it a point to become familiar with the procedures and equipment that are to be used. Work only with chemical products when you know their flammability, reactivity, toxicity, safe handling, storage, and emergency procedures. If you don't understand or are unclear about something, ask! The following guidelines are recommended for working safely in a lab:

Personal Safety Practices

1. Lab coats and safety glasses are required in laboratories employing chemicals, biohazards, or radioisotopes. Never wear shorts, sandals, or open-toed shoes in lab.
2. Do not allow children or pets in laboratories.
3. Never pipette anything by mouth.
4. Be aware of dangling jewelry, loose clothing, or long hair that might get caught in equipment.
5. Store food and drinks in refrigerators that are designated for that use only.
6. 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.
7. Wash your hands frequently throughout the day and before leaving the lab.
8. 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.
9. Contact lenses should not be worn in a lab because chemicals or particulates can get caught behind them and cause severe damage to the eye.

Housekeeping:

1. Work areas must be kept clean and free of unnecessary chemicals. Clean your work area throughout the day and before you leave at the end of the day.
2. If necessary, clean equipment after use to avoid the possibility of contaminating the next person who needs to use it.
3. Keep all aisles and walkways in the lab clear to provide a safe walking surface and an unobstructed exit.
4. Do not block access to emergency equipment and utility controls.

(b) Accidents and Spills

See the Emergency Procedures section for detailed procedures.

Supplies for cleaning up a minor chemical or biological spill must be readily available. In case of release, promptly clean up spills, using appropriate protective apparel and equipment.

Spill Response Equipment:

1. Supplies for a chemical spill include an inert absorbent such as kitty litter or vermiculite or a 50/50 mixture of the two, a plastic (non-sparking) scoop, plastic bags for the spilled material, heavy gloves, goggles, and sodium bicarbonate to neutralize acids. Kits are commercially available which include acid, base, flammable, or universal pillows or booms.

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

Note: All spent spill clean up materials must be disposed of in the same manner as the spilled chemical.

(c) Avoidance of "Routine" Exposure

Develop and encourage safe habits; avoid unnecessary exposure to chemicals by any route. Do not smell or taste chemicals. Vent apparatus which may discharge toxic chemicals (e.g., vacuum pumps, distillation columns) into local exhaust devices. Inspect gloves and test glove boxes before use. Do not allow release of toxic substances in cold rooms or warm rooms, since these have contained recirculated atmospheres.

(d) Choice of Chemicals

Use only those chemicals for which the quality of the available ventilation system is appropriate as determined by the laboratory supervisor or Principal Investigator

(e) Eating, Smoking, etc.

Do not eat, drink, chew gum, or apply cosmetics in areas where laboratory chemicals are present; wash hands before conducting these activities. Smoking is not allowed in University buildings.

(f) Equipment and Glassware

OEHS recommends the following guidelines for the use and care of glassware and other laboratory equipment

Glassware:

1. Inspect all glassware before use. Repair or discard any broken, cracked, or chipped glassware.

2. Tape or shield glass vacuum vessels to prevent flying glass in the case of an implosion. Also, tape or shield glass vacuum dessicators.

3. Do not use household Thermos bottles as a substitute for laboratory Dewar flasks; the walls are too thin.

4. Transport all glass chemical containers in rubber or polyethylene bottle carriers.

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

6. Practice the following when inserting glass tubes or rods into stoppers:

    i. be certain that the diameter of the tube is compatible with the diameter of the stopper,
    ii. fire-polish the end of the glass tube,

iii. lubricate the glass with water or glycerol,
iv. wear heavy gloves and hold the glass not more than two inches from the end to be inserted,
v. insert the glass carefully with a twisting motion, and
vi. remove stuck tubes by slitting the stopper with a sharp knife.

Assembly of Laboratory Apparatus:

1. Keep work surfaces as uncluttered as possible.
2. Firmly clamp apparatus and set up away from the edge of the lab bench.
3. Only use equipment that is free from cracks, chips, or other defects.
4. If possible, place a pan under a reaction vessel or other container to contain liquid if the glassware breaks.
5. Do not allow burners or any other ignition sources nearby when working with flammable liquids.
6. Lubricate glass stopcocks.
7. Properly support and secure condensers and water hoses with clamps and wires. Be sure to direct the water hoses so that any drips that may come off the hoses do not splash down onto any electrical wires.
8. Position apparatus that is attached to a ring stand with the center of gravity over the base and not to one side.
9. Assemble the apparatus so that burners or baths can be removed quickly.
10. Use an appropriate vapor trap and confine the setup to a fumehood if there is a possibility of hazardous vapors being evolved.
11. Put the setup in a fumehood whenever conducting a reaction that could result in an implosion or explosion. Keep the sash pulled down. If it is not possible to use a fumehood, use a standing shield that is stabilized and secured.
12. Always wear a lab coat and proper eye and face protection.

Centrifuges

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

Ultraviolet Lamps

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

Lasers

1. Always wear goggles that protect against the specific wavelength of the laser.
2. Never look directly at the beam.
3. Do not allow any reflective materials in or along the beam.
4. Post warning signs in all laser areas. If possible, use a flashing light at the lab entrance to indicate when a laser is in use.
5. Contact the OEHS Laser Safety Officer for more information.

Separatory Funnels

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

Cooling Baths and Cold Traps

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

Vacuum Pumps

1. If possible, vent vacuum pump exhaust into a fume hood.
2. Guard all belt-driven vacuum pumps to prevent hands or loose clothing from getting caught in the belt pulley.
3. Place a trap between the vacuum pump and the apparatus.
4. Lubricate pump regularly if possible. Check belt conditions and do not operate in a fumehood cabinet that is used for storage of flammables.

Electrical

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

(g) Personal Protection

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 required for the particular work you are performing.

Protective Eyewear:

1. Goggles provide the best all around protection against chemical splashes, vapors, dusts, and mists.
2. Goggles that have indirect vents or are non-vented provide the most protection, but an anti-fog agent may need to be applied.
3. Standard safety glasses provide protection against impact.
4. If using a laser, wear safety glasses or goggles, which provide protection against the specific wavelength of that laser.
5. Remember, prescription glasses do not provide adequate protection in a laboratory setting. Prescription safety glasses can be purchased from most opticians.
6. Contact lenses should not be worn in a laboratory because they can trap contaminants behind them and reduce or eliminate the effectiveness of flushing with water from an eyewash. Contact lenses may also increase the amount of chemicals trapped on the surface of the eye and decrease removal of the chemical by tearing. If it is necessary to wear contact lenses in a lab, wear protective goggles at all times.

Protective Gloves

1. Any glove can be permeated by chemicals. The rate at which this occurs depends on the composition of the glove, the chemicals present and their concentration, and the exposure time to the glove. 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 (see Appendix XI for glove suitability information).
2. If direct chemical contact occurs, replace gloves regularly throughout the day. Wash hands regularly and remove gloves before answering the telephone or opening doors to prevent the spread of contamination.
3. Check gloves for cracks, tears, and holes.
4. Butyl, neoprene, and nitrile gloves are resistant to most chemicals, e.g., alcohols, aldehydes, ketones, most inorganic acids, and most caustics.
5. Disposable latex and vinyl gloves protect against some chemicals, most aqueous solutions, and microorganisms and reduce risk of product contamination.

Note: There is increasing evidence that some people develop a serious allergic reaction to latex.

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

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

Other Protective Clothing:

1. The primary purpose of a lab coat is to protect against splashes and spills. A lab coat should be nonflammable, where necessary, and should be easily removed. Many different kinds of lab coats are available.

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

3. Face shields can protect against impact, dust, particulates, and chemical splashes for the face, eyes, and throat. However, always wear protective eyewear such as goggles underneath a face shield because a face shield only offers additional protection to the eyes. Chemical vapors and splashes can still travel under and around a face shield. If scratches or cracks are noticed in the face shield, replace the window.

4. Shoes which fully cover the feet should always be worn in a lab. If work is going to be performed that includes moving large and heavy objects such as 55 gallon drums, steel-toed shoes must be worn.

In general, the lab supervisor must ensure that appropriate personal protective equipment is worn by all persons, including visitors, in areas where chemicals are stored or handled.

(h) Planning

Seek information and advice about hazards, write appropriate protective procedures, and plan positioning or equipment before beginning any new operation.

(i) Unattended Operations

Leave lights on, place an *appropriate* sign on the door, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water) to an unattended operation.

(j) Use of Hood

Use the hood for all procedures which might result in the release of hazardous chemical vapors of dust. Confirm that the hood is working before use by holding a Kimwipe®, or other lightweight paper, up to the opening of the hood. The paper should be pulled

inward. Leave the hood "on" when it is not in active use if toxic substances are stored inside or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off."

Proper Use of Fume Hoods

1. Equipment and other materials should be placed at least six inches behind the sash. This will reduce the exposure of personnel to chemical vapors that may escape into the lab due to air turbulence.
2. When the hood is not in use, pull the sash all the way down. While personnel are working at the hood, pull down the sash as far as is practical. The sash is your protection against fires, explosions, chemical splashes, and projectiles.
3. Do not keep loose papers, paper towels, or tissues (e.g., Kimwipes®) in the hood. These materials can be drawn into the blower and adversely affect the performance of the hood.
4. Do not use a fume hood as a storage cabinet for chemicals. Excessive storage of chemicals and other items will disrupt the designed airflow in the hood. In particular, do not store chemicals against the baffle at the back of the hood, because this will interfere with the laminar airflow across the hood.
5. If large equipment must be kept in a fume hood, raise it 1.5 inches off the work surface to allow air to flow underneath. This dramatically reduces the turbulence within the hood and increases its efficiency.
6. Do not place objects directly in front of a fume hood (such as refrigerators or lab coats hanging on the manual controls) as this can disrupt the airflow and draw contaminants out of the hood.
7. Keep in mind that modifications made to a fume hood system, e.g., adding a snorkel, can render the entire system ineffective.
8. Minimize the amount of foot traffic immediately in front of a hood. Walking past hoods causes turbulence that can draw contaminants out of the hood and into the room.

(k) Storage of Chemicals in the Lab

Please refer to the section on laboratory chemical storage in Chapter C.1.

2. Working with Allergens

A wide variety of substances can illicit skin and lung hypersensitivity. Examples include common substances such as diazomethane, chromium, nickel, bichromates, formaldehyde, isocyanates, and certain phenols. Because of this variety and the varying response of individuals, suitable gloves should be used whenever there is potential for contact with chemicals that may cause skin irritation.

3. Working with Embryotoxins

Embryotoxins are substances that act during pregnancy to cause adverse effects on the

developing fetus. These effects may include embryolethality (death of the fertilized egg, the embryo, or the fetus), malformations (teratogenic effects), retarded growth, and postnatal function deficits.

A few substances have been demonstrated to be embryotoxic in humans. These include:

acrylic acid	diphenylamine	nitrobenzene
aniline	estradiol	nitrous oxide
benzene	formaldehyde	phenol
cadmium	formamide	thalidomide
carbon disulfide	hexachlorobenzene	toluene
N,N-dimethylacetamide	iodoacetic acid	vinyl chloride
dimethylformamide	lead compounds	xylene
dimethyl sulfoxide	mercury compounds	polychlorinated and polybrominated biphenyls

Maternal alcoholism is probably the leading known cause of embryotoxic effects in humans, but the exposure to ethanol typically encountered in laboratories is unlikely to be embryotoxic. Many substances, some as common as sodium chloride, have been shown to be embryotoxic to animals at some exposure level, but usually this is at a considerably higher level than is met in the course of normal laboratory work. However, some substances do require special controls due to embryotoxic properties. One common example is formamide: women of childbearing potential should handle this substance only in a hood and should take precautions to avoid skin contact with the liquid because of the ease with which it passes through the skin.

Because the period of greatest susceptibility to embryotoxins is the first 8-12 weeks of pregnancy, which includes a period when a woman may not know that she is pregnant, women of childbearing potential should take care to avoid skin contact with all chemicals. The following procedures are recommended to be followed routinely by women of childbearing potential in working with chemicals requiring special control because of embryotoxic properties:

1. Each use must be reviewed for particular hazards by the Principal Investigator or Lab Supervisor, who will decide whether special procedures are warranted or whether warning signs should be posted. Consultation with appropriate safety personnel may be desirable. In cases of continued use of a known embryotoxin, the operation should be reviewed annually or whenever a change in procedures is made.

2. Embryotoxins requiring special control should be stored in an adequately ventilated area. The container should be labeled in a clear manner such as the following: **EMBRYOTOXIN: READ SPECIFIC PROCEDURES FOR USE.** If the storage container is breakable, it should be kept in an impermeable, unbreakable secondary container having sufficient capacity to retain the material, should the primary container fail.

3. Women of childbearing potential should take adequate precautions to guard against spills and splashes. Operations should be carried out using impermeable containers and in adequately ventilated areas. Appropriate safety apparel, especially gloves, should be worn. All hoods, glove boxes, or other essential engineering controls should be operating at required efficiency before work is started.

4. Supervisors must be notified regarding all incidents of exposure or spills of embryotoxins requiring special control. A qualified physician should be consulted about any exposures of women of childbearing potential above the acceptable level (i.e., any skin contact or inhalation exposures).

4. Working with Chemicals of Moderate Chronic or High Acute Toxicity

Before beginning a laboratory operation, each worker is strongly advised to consult one of the standard compilations that list toxic properties of known substances and learn what is known about the substance to be used. The precautions and procedures described in this section should be followed if any of the substances to be used in significant quantities is known to be moderately or highly toxic (if any of the substances being used is known to be highly toxic, it is desirable that two people be present in the area at all times).

These procedures should also be followed if the toxicological properties of any of the substances being used or prepared are unknown. If any of the substances to be used or prepared are known to have high, chronic toxicity (e.g., compounds of heavy metals and other potent carcinogens), then the precautions and procedures described below should be supplemented with additional precautions to aid in containing and ultimately destroying the substances having high chronic toxicity. Some examples of potent carcinogens (substances known to have high chronic toxicity), along with their corresponding chemical class, are:

Alkylating Agents:

α-halo ethers
- bis(chloromethyl) ether
- methyl chloromethyl ether

aziridines
- ethylene imine
- 2-methylaziridine

diazo, azo, and azoxy compounds
- 4-dimethylaminoazobenzene

electrophilic alkenes and alkynes
- acrylonitrile
- acrolein
- ethyl acrylate

epoxides
- ethylene oxide
- diepoxybutane
- epichlorohydrin
- propylene oxide
- styrene oxide

sulfonates
- diethyl sulfate
- dimethyl sulfate
- ethyl methanesulfonate
- methyl methanesulfonate
- methyl trifluoromethanesulfonate
- 1,3-propanesultone
- 1,4-butanedioldimethanesulfonate

Acylating Agents:

- β-propiolactone
- β-butyrolactone
- dimethylcarbamoyl chloride

Organohalogen Compounds:

- 1,2-dibromo-3-chloropropane
- vinyl chloride
- chloroform
- methyl iodide
- 2,4,6-trichlorophenol
- bis(2-chloroethyl) sulfide
- carbon tetrachloride
- hexachlorobenzene
- 1,4-dichlorobenzene

Natural Products:

- adriamycin
- bleomycin
- progesterone
- aflatoxins
- reserpine
- safrole

Inorganic Compounds:

- cisplatin

Aromatic Amines:

- 4-aminobiphenyl
- aniline
- *o*-anisidine
- benzidine
- *o*-toluidine

The overall objective of the procedures outlined in this section is to minimize exposure of the laboratory worker to toxic substances by taking all reasonable precautions. Thus, the general precautions outlined in Section D.1 should normally be followed whenever a toxic substance is being transferred from one container to another or is being subjected to some chemical or physical manipulation. The following three precautions should always be followed:

1. Protect the hands and forearms by wearing either gloves and a laboratory coat or suitable long gloves to avoid contact of the toxic material with the skin.
2. Procedures involving volatile toxic substances and those involving solid or liquid toxic substances that may result in the generation of aerosols should be conducted in a hood or other suitable containment device.

3. After working with toxic materials, wash the hands and arms immediately. Never eat, drink, chew gum, apply cosmetics, take medicine, or store foods in areas where toxic substances are being used.

These standard precautions will provide laboratory workers with good protection from most toxic substances. In addition, records that include amounts of material used and names or workers involved should be kept as part of the laboratory notebook record of the experiment. To minimize hazards from accidental breakage of apparatus or spills of toxic substances in the hood, containers of such substances should be stored in pans or trays made of polyethylene or other chemically resistant material and apparatus should be mounted above trays of the same type of material. Alternatively, the working surface of the hood can be fitted with a removable liner of adsorbent plastic-backed paper. Such procedures will contain spilled toxic substances in a pan, tray, or absorbent liner and greatly simplifies subsequent cleanup and disposal. Vapors that are discharged from the apparatus should be trapped or condensed to avoid adding substantial amounts of toxic vapor to the hood exhaust air. Areas where toxic substances are being used and stored must have restricted access, and warning signs should be posted if a special toxicity hazard exists.

The general waste disposal procedures described in the OEHS Waste Disposal manual must be followed for these types of chemicals. In general, the waste materials and solvents containing toxic substances should be stored in closed, impervious containers so that personnel handling the containers will not be exposed to their contents.

The laboratory worker must be prepared for potential accidents or spills involving toxic substances. If a toxic substance contacts the skin, the area should be washed with water. If there is a major spill outside of the hood, the room or appropriate area should be evacuated and necessary measures should be taken to prevent exposure of other workers. Spills must be cleaned by personnel wearing suitable personal protective apparel. If a spill of a significant quantity of toxic material occurs outside the hood, an air-supplied full-face respirator should be worn.

In addition to the precautions described in this section, we strongly advise researchers to develop written standard operating procedures intended to establish a concise, step-by-step method for carrying out routine laboratory operations with the substance in question.

5. Working with Substances of High Chronic Toxicity

All of the procedures and precautions described in the previous section should be followed when working with substances known to have high chronic toxicity. In addition, when such substances are to be used in quantities exceeding a few milligrams to a few grams, depending on the hazards posed by the particular substance, the additional precautions described in this section should be used. Each laboratory worker's plan for experimental work and for disposing of waste materials must be approved by the laboratory supervisor. Consultation with the departmental Chemical Hygiene Officer may be appropriate to ensure that the toxic material is effectively contained during the experiment and that waste materials are disposed of in a safe manner. Substances in this high chronic toxicity category include certain heavy metal compounds (e.g., dimethylmercury and nickel carbonyl) and compounds normally classified as strong carcinogens. Examples of compounds normally classified as strong carcinogens include the following:

2-acetylaminofluorene
aflatoxin B_1
benzo[a]pyrene
bis(chloromethyl) ether
7,12-dimethylbenz[a]anthracene
dimethylcarbamoyl chloride
hexamethylphosphoramide
3-methylcholanthrene
2-nitronaphthalene
propane sultone
various *N*-nitrosamides
various *N*-nitrosamines

An accurate record of the amounts of such substances being stored and the amounts used, dates of

use, and names of users must be maintained. It is appropriate to keep such records as part of the record of experimental work in the laboratory workers' research notebook, but it must be understood that the research supervisor is responsible for ensuring that accurate records are maintained.

Any volatile substances having high chronic toxicity must be stored in a ventilated storage area in a secondary tray or container having sufficient capacity to contain the material should the primary storage container fail. All containers of substances in this category must have labels that identify that contents and include a warning such as: **WARNING! HIGH CHRONIC TOXICITY OR CANCER SUSPECT AGENT**. Storage areas for substances in this category must have limited access, and special signs should be posted if a special toxicity hazard exists. Any area used for storage of substances of high chronic toxicity must be maintained under negative pressure with respect to the surroundings.

All experiments with and transfers of such substances or mixtures containing such substances must be done in a controlled area (i.e., a laboratory, or a portion of a laboratory, or a facility such as an exhaust hood or a glove box that is designated for the use of highly toxic substances. Its use need not be restricted to the handling of highly toxic substances if all personnel who have access to the controlled area are aware of the nature of the substances being used and the precautions that are necessary). When a glove box is used, the ventilation rate in the box must be at least two volume changes per hour, the pressure should be at least 0.5 inches of water lower than that of the surrounding environment, and the exit gases should be passed through a trap or HEPA filter.

Positive pressure glove boxes are normally used to provide an inert anhydrous atmosphere. If these glove boxes are used with highly toxic compounds, then the box should be thoroughly checked for leaks before use and the exit gases should be passed through a suitable trap or filter. Laboratory vacuum pumps used with substances having high chronic toxicity should be protected by high-efficiency scrubbers or HEPA filters and vented into an exhaust hood. Motor-driven vacuum pumps are recommended because they are easy to decontaminate.

Proper gloves must be worn when transferring or otherwise handling substances or solutions of substances having high chronic toxicity. In some cases, the laboratory worker or the research supervisor may deem it advisable to use other protective apparel, such as an apron of reduced permeability covered by a disposable coat. Extreme precautions such as these might be taken, for example, when handling large amounts of certain heavy metals and their derivatives or compounds known to be potent carcinogens. Surfaces on which high chronic toxicity substances are handled must be protected from contamination by using chemically resistant trays or pans that can be decontaminated after the experiment or by using dry, absorbent plastic-backed paper that can be disposed of after use.

On leaving a controlled area, laboratory workers must remove any used protective apparel and thoroughly wash hands, forearms, face, and neck. If disposable apparel or absorbent paper liners have been used, these items must be placed in a closed and impervious container that should then be labeled in some manner such as: **CAUTION: CONTENTS CONTAMINATED WITH SUBSTANCES OF HIGH CHRONIC TOXICITY** (for waste disposal purposes, chemical names are required). Non-disposable protective apparel should be thoroughly washed, and containers of non reusable apparel and protective liners must be disposed of through OEHS.

Wastes and residues must be placed in an impervious container and disposed of through OEHS. In general, liquid wastes containing such compounds must be placed in a glass or polyethylene bottle half filled with vermiculite.

Normal laboratory work must not be resumed in a space that has been used as a controlled area until it has been adequately decontaminated. Work surfaces must be thoroughly washed and rinsed. If experiments have involved the use of finely divided solid materials, dry sweeping should not be done. In such cases, surfaces must be cleaned by wet mopping or by use of a vacuum cleaner equipped with a HEPA filter. All equipment (e.g., glassware, vacuum pumps, and containers) that is known or suspected to have been in contact with substances of high chronic toxicity should be washed and rinsed before it is removed from the controlled area.

In the event of continued experimentation with a substance of high chronic toxicity (i.e., if a worker regularly uses toxicologically significant quantities of such a substance at least three times a week), a qualified physician must be consulted to determine whether it is advisable to establish a regular schedule of medical surveillance or biological monitoring. Contact OEHS Hazardous Materials Division (471-3511) for the name of a physician that might be used for this purpose.

In addition to the precautions described in this section, lab supervisors must develop written standard operating procedures intended to establish a concise, step-by-step method for carrying out routine laboratory operations with the substance in question. These procedures must be approved by the respective departmental chemical hygiene officer.

References:

CRC Handbook of Laboratory Safety, Third Edition. A. K. Furr, Ed. Chemical Rubber Company. 1990. (704 page reference on all aspects of lab safety.)

Prudent Practices for Handling Hazardous Chemicals in Laboratories. Prepared by the National Research Council. 1981. (291 pages)

Prudent Practices in the Laboratory. National Research Council. 1995. (427 pages)

Safe Storage and Handling of Laboratory Chemicals - A Review of Safe Storage and Handling Practices for Laboratory Chemicals. Nancy Magnussen. Texas A&M University Chemistry Safety Coordinator.

Safety in Academic Chemistry Laboratories. American Chemical Society. 1990.

E. Procedures for Specific Classes of Hazardous Materials

The specific rules and procedures for working with hazardous chemicals, as outlined in the preceding section, give insight into the proper methods for handling materials which pose significant hazards due primarily to their chronic toxicity. However, these specific rules and procedures, along with the general rules for working with chemicals, do not address some of the basic physical hazards which may stem from acute exposure to different types of laboratory chemicals. This section offers some specific guidelines for working with common laboratory chemicals that, for varying reasons, are acutely toxic in the sense that they may cause considerable harm to human life and health pending short-term exposures. This section will address five fundamental classes of laboratory chemicals: flammables, corrosives, oxidizers, reactives, and compressed gases. These classes of chemicals may include chemicals that are also covered in the previous section regarding their property of toxicity.

1. Flammable Solvents

(a) Terms and Definitions

Flammable liquids are indeed the most common chemicals found in a laboratory. The primary hazard associated with flammable liquids is, of course, their ability to readily ignite and burn. One should note that it is the vapor of a flammable liquid, not the liquid itself, that ignites and causes a fire.

1. The rate at which a liquid vaporizes is a function of its *vapor pressure*. In general, liquids with high vapor pressures evaporate at a higher rate compared to liquids of lower vapor pressure. It should be noted that the vapor pressure increases rapidly as the temperature is raised as does the evaporation rate. A reduced-pressure environment also accelerates the rate of evaporation.

2. The *flash point* of a liquid is the lowest temperature at which a liquid gives off vapor at such a rate as to form an air:vapor mixture that will ignite, but will not sustain ignition. Many commonly used flammable solvents have flashpoints significantly lower than room temperature:

Compound	Flash Point (°C)
diethyl ether	- 45.0
acetone	- 17.8
isopropyl alcohol	11.7

3. The *limits of flammability or explosivity* define the range of fuel:air mixtures that will sustain combustion. The lower limit of this range is called the *Lower Explosive Limit* or LEL, and the higher limit of this range is called the *Upper Explosive Limit* or UEL. Materials with very broad flammability ranges (e.g., acetylene, LEL = 3%, UEL = 65%) are particularly treacherous due to the fact that virtually any fuel:air combination may form an explosive atmosphere.

4. The *vapor density* of a flammable material is the density (mass to volume ratio) of the corresponding vapor relative to air under specific temperature and pressure conditions. Flammable vapors with densities greater than unity (and thus "heavier" than air) are potentially lethal because they will accumulate at floor level and flow, with remarkable ease, in much the same manner that a liquid would. The obvious threat is that these mobile vapors may eventually reach an ignition source, such as an electrical outlet or a Bunsen burner at another student's bench.

(b) Examples of Flammable Liquids

acetone
ethyl ether
toluene
methyl formate

(c) Use and Storage of Flammables

1. Flammable liquids that are not in active use must be stored in safe containers inside fire resistant storage cabinets designed for flammables, or inside storage rooms.
2. Minimize the amount of flammable liquids stored in the lab.
3. Use flammables only in areas free of ignition sources. Remember, smoking is not permitted inside any University building.
4. The transfer of material to or from a metal container is generally accompanied by an accumulation of static charge on the container. This fact must be kept in mind when transferring flammable liquids, since the discharge of this static charge could generate a spark, thereby igniting the liquid. To make these transfers safer, flammable liquid dispensing and receiving containers must be bonded together before pouring. Large containers such as drums must also be grounded when used as dispensing or receiving vessels. All grounding and bonding connections must be metal to metal. (The aforementioned bonding and grounding wires may be found in most lab safety catalogs.)
5. Never heat flammables with an open flame. Instead, use steam baths, water baths, oil baths, hot air baths, sand baths or heating mantles.
6. Never store flammable chemicals in a standard household refrigerator. There are several ignition sources located inside a standard refrigerator that can set off a fire or violent explosion. Flammables can only be stored cold in a lab safe or explosion-proof refrigerator. Another alternative is to use an ice bath to chill the chemicals. Remember, there is no safety benefit in storing a flammable chemical in a refrigerator if the flashpoint of that chemical is below the temperature of the refrigerator.

(d) Health Hazards Associated with Flammables

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

Acute Health Effects:

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

Ingestion - slight gastro-intestinal irritation, dizziness, fatigue

Skin Contact - dry, cracked, and chapped skin

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

Chronic Health Effects:

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

Flammable Groups Exhibiting Similar Health Effects:

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

Alcohols - vapors only moderately narcotic.

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

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

Ketones - systemic toxicity is generally not high.

(e) First Aid Procedures for Exposures to Flammable Materials

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

Ingestion Exposures - remove the person, if possible, from the source of contamination. Get medical attention.

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

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

(f) 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 to provide a barrier to your skin and goggles if splashing is likely to occur (also see Appendix XI for glove information).

2. Oxidizers

(a) General Characteristics

1. Oxidizers or oxidizing agents present fire and explosion hazards on contact with combustible materials. Depending on the class, an oxidizing material may increase the burning rate of combustibles with which it comes in contact; cause the spontaneous ignition of combustibles with which it comes in contact; or undergo an explosive reaction when exposed to heat, shock, or friction.

2. Oxidizers are generally corrosive.

(b) Examples of Common Oxidizers

peroxides	nitrates
nitrites	perchlorates
chlorates	chlorites
hypochlorites	dichromates

(c) Use and Storage of Oxidizers

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

2. Strong oxidizing agents like chromic acid should be stored in glass or some other inert container, preferably unbreakable. Corks and rubber stoppers should not be used.

3. Reaction vessels containing appreciable amounts of oxidizing material should never be heated in oil baths, but rather on a heating mantle or sand bath.

(d) Use and Storage of Perchloric Acid

1. 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.

2. 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 specially equipped with a washdown system to remove any perchloric acid residue. The hood should be washed down after each use and it is preferred to dedicate the hood to perchloric acid use only.

3. Whenever possible, substitute a less hazardous chemical for perchloric acid.

4. Perchloric acid can 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. A bottle of perchloric acid should also be stored in a glass secondary container to contain leakage.

5. Do not allow perchloric acid to come in contact with any strong dehydrating agents such as sulfuric acid. The dehydration of perchloric acid is a severe fire and explosion hazard.
6. Do not order or use anhydrous perchloric acid. It is unstable at room temperature and can decompose spontaneously with a severe explosion. Anhydrous perchloric acid will explode upon contact with wood.

(e) Health Hazards Associated with Oxidizers

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

Acute Health Effects:

Some oxidizers such as nitric and sulfuric acid vapors, chlorine, and hydrogen peroxide act as irritant gases. All irritant gases can cause inflammation in the surface layer of tissues when in direct contact. They can also cause irritation of the upper airways, conjunctiva, and throat.

Some oxidizers, such as fluorine, can cause severe burns of the skin and mucus membranes. Chlorine trifluoride is extremely toxic and can cause severe burns to tissue.

Nitrogen trioxide is very damaging to tissue, especially the respiratory tract. The symptoms from an exposure to nitrogen trioxide may be delayed for hours, but fatal pulmonary edema may result.

Osmium tetroxide, another oxidant commonly employed in the laboratory, is also dangerous due to its high degree of acute toxicity. It is a severe irritant of both the eyes and the respiratory tract. Inhalation can cause headache, coughing, dizziness, lung damage, difficulty breathing and may be fatal. Osmium tetroxide is regarded by many in the field as having "poor warning properties." This is due to the fact that it is difficult to detect in the atmosphere (by smell or other means). The OHSA-defined Permissible Exposure Limit for osmium tetroxide is 0.0002 ppm, while its odor threshold is 2 ppm - this means that one could conceivably be exposed to osmium tetroxide at concentrations 10,000 times the PEL without knowing it. For this reason, it is

recommended that laboratories using osmium tetroxide have necessary safeguards in place before the container is even opened.

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.

(f) First Aid

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

(g) Personal Protective Equipment

In many cases, the glove of choice will be neoprene, polyvinyl chloride (PVC), or nitrile. Be sure to consult a glove compatibility chart to ensure the glove material is appropriate for the particular chemical you are working with (see Appendix XI for information on glove suitability and availability).

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

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

3. Corrosives

(a) General Characteristics

1. Corrosives are most commonly acids and alkalis, but many other materials can be severely damaging to living tissue.
2. Corrosives can cause visible destruction or irreversible alterations at the site of contact. Inhalation of the vapor or mist can cause severe bronchial irritation. Corrosives are particularly damaging to the skin and eyes.
3. Certain substances considered non-corrosive in their natural dry state are corrosive when wet such as when in contact with moist skin or mucus membranes. An example of these materials are lithium chloride, halogen fluorides, and allyl iodide.
4. Sulfuric acid is a very strong dehydrating agent and nitric acid is a strong oxidizing agent. Dehydrating agents can cause severe burns to the eyes due to their affinity for water.

(b) Examples of Corrosives

sulfuric acid	ammonium bifluoride
chromic acid	bromine
stannic chloride	ammonium hydroxide

(c) Use and Storage of Corrosives

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

(d) Use and Storage of Hydrofluoric Acid

1. Hydrofluoric acid is extremely hazardous and deserves special mention. Hydrofluoric acid can cause severe burns and inhalation of anhydrous hydrogen fluoride can be fatal. Initial skin contact with hydrofluoric acid may not produce any symptoms.
2. Only persons fully trained in the hazards of hydrofluoric acid should use it.
3. Always use hydrofluoric acid in a properly functioning fume hood. Be sure to wear personal protective clothing!
4. If you suspect that you have come in direct contact with hydrofluoric acid: wash the area with water for at least 15 minutes, remove clothing, then promptly seek medical attention. If hydrogen fluoride vapors are inhaled, move the person immediately to an uncontaminated atmosphere (if safe to do so), keep the person warm, and seek prompt medical attention.
5. Never store hydrofluoric acid in a glass container because it is incompatible with glass.
6. Store hydrofluoric acid separately in an acid storage cabinet and keep only that amount necessary in the lab.
7. Creams for treatment of hydrofluoric acid exposure are commercially available.

(e) Health Hazards Associated with Corrosives

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

Skin contact with alkali metal hydroxides, e.g., sodium hydroxide and potassium hydroxide, is more dangerous than with strong acids. Contact with alkali metal hydroxides normally causes deeper tissue damage because there is less pain than with an acid exposure. The exposed person may not wash it off thoroughly enough or seek prompt medical attention.

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

Acute Health Effects:

Inhalation - irritation of mucus membranes, difficulty in breathing, fits of coughing, pulmonary edema

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

Skin Contact - burning, redness and swelling, painful blisters, profound damage to tissues, and with alkalis; a slippery, soapy feeling

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

Chronic Health Effects:

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

(f) First Aid

Inhalation - remove person from source of contamination if safe to do so. Get medical attention. Keep person warm and quiet and do not leave unattended.

Ingestion - remove person from source of contamination. Get medical attention and inform emergency responders of the name of the chemical swallowed.

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

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

(g) Personal Protective Equipment

Always wear the proper gloves when working with acids. Neoprene and nitrile gloves are effective against most acids and bases. Polyvinyl chloride (PVC) is also effective for most acids (see Appendix XI for more glove compatibility information). A rubber coated apron and goggles should also be worn. If splashing is likely to occur, wear a face shield over the goggles. Always use corrosives in a chemical fume hood.

4. Reactives

(a) 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 heat. An example of a chemical which can undergo a polymerization reaction is styrene.

Water Reactive Materials

1. When water reactive materials come in contact with water, one or more of the following can occur: liberation of heat which may cause ignition of the chemical itself if it is flammable, or ignition of flammables that are stored nearby; release of a flammable, toxic, or strong oxidizing gas; release of metal oxide fumes; and formation of corrosive acids.

2. Water reactive chemicals can be particularly hazardous to firefighting personnel responding to a fire in a lab, because water is the most commonly used fire extinguishing medium. Examples of water reactive materials:

alkali metals:
lithium, sodium, potassium
magnesium
silanes
alkylaluminums
zinc
aluminum

Pyrophorics - Pyrophoric materials can ignite spontaneously in the presence of air. Examples of pyrophoric materials:

diethylzinc
triethylaluminum
many organometallic compounds

Peroxide-Forming Materials - 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 peroxides. The tendency to form peroxides by most of these materials is greatly increased by evaporation or distillation. Organic peroxides are extremely sensitive to shock, sparks, heat, friction, impact, and light. Many peroxides formed from materials used in laboratories are more shock sensitive than TNT. Just the friction from unscrewing the cap of a container of an ether that has peroxides in it can provide enough energy to cause a severe explosion.

Examples of peroxide-forming materials (the first group listed is the most hazardous):

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

Note: See Appendix XII for list of more peroxide forming chemicals.

Other Shock-Sensitive Materials - These materials are explosive and sensitive to heat and shock.

Examples of shock-sensitive materials:

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

Note: See Appendix XIII for a complete list of potentially explosive chemicals.

(b) Use and Storage of Reactives

1. A good way to reduce the potential risks is to minimize the amount of material used in the experiment. Use only the amount of material necessary to achieve the desired results.

2. Always substitute a less hazardous chemical for a highly reactive chemical whenever possible. If it is necessary to use a highly reactive chemical, order only the amount that is necessary for the work.

Water Reactive Materials

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

Pyrophorics

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

Peroxide-Forming Materials

1. Do not open the chemical container if peroxide formation is suspected. The act of opening the container could be sufficient to cause a severe explosion. Visually inspect liquid peroxide-forming materials for crystals or unusual viscosity before opening. Pay special attention to the area around the cap. Peroxides usually form upon evaporation, so they will most likely be formed on the threads under the cap.

2. Date all peroxide forming materials with the date received, and the expected shelf life. Chemicals such as diisopropyl ether, divinyl acetylene, sodium amide, and vinylidene chloride should be discarded after three months. Chemicals such as dioxane, diethyl ether, and tetrahydrofuran should be submitted to OEHS for disposal after one year.

3. Store all peroxide-forming materials away from heat, sunlight, and sources of ignition. Sunlight accelerates the formation of peroxides.

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

5. Never store peroxide-forming materials in glass containers with screw cap lids or glass stoppers. Friction and grinding must be avoided. Also, never store these chemicals in a clear glass bottle where they would be exposed to light.

6. Contamination of an ether by peroxides or hydroperoxides can be detected simply by mixing the ether with 10% (wt/wt) aqueous potassium iodide solution - a yellow color change due to the oxidation of iodide to iodine confirms the presence of peroxides. Small amounts of peroxides can be removed from contaminated ethers via distillation from lithium aluminum hydride (LiAlH-4-), which both reduces the peroxide and removes contaminating water and alcohols. However,

if you suspect that peroxides may be present, it would be wise to call the OEHS for disposal. If you notice crystal formation in the container or around the cap, do not attempt to open or move the container. Call the OEHS for proper disposal.

7. Never distill an ether unless it is known to be free of peroxides.

Other Shock Sensitive Materials

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

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

(c) Health Hazards Associated with Reactives

Reactive chemicals are grouped 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 OEHS. However, there are some hazards common to the use of reactive materials. Injuries can occur due to heat or flames, inhalation of fumes, vapors, and reaction products, and flying debris.

First Aid

If someone is seriously injured the most important step to take is to contact emergency responders as quickly as possible. This is best accomplished by directly calling them at 9-911. Explain the situation and describe the location clearly and accurately.

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

If a person's clothes are on fire, he or she should drop immediately to the floor and roll. If a fire blanket is available, put it over the individual. An emergency shower, if one is immediately available, can also be used to douse flames.

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

Personal Protective Equipment

Wear appropriate personal protective clothing while working with highly reactive materials. This might include: impact resistant safety glasses or 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. While 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.

5. Compressed Gas Cylinders

General Characteristics:

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

Purchase Policy

Purchase of gases in non-returnable cylinders is restricted by policy at The University (see Appendix XIV for the Gas Cylinder Policy).

Use and Storage

1. Whenever possible, use flammable and reactive gases in a fume hood or other ventilated enclosure. As noted in Chapter C.2., concerning storage cabinets, certain categories of toxic gases must always be stored and used in ventilated enclosures.
2. Always use the appropriate regulator on a cylinder. If a regulator will not fit a cylinder's valve, replace the cylinder, not the regulator. Do not attempt to adapt or modify a regulator to fit a cylinder it was not designed for. Regulators are designed to fit only specific cylinder valves to avoid improper use.
3. Inspect regulators, pressure relief devices, valves, cylinder connections, and hose lines frequently for damage.
4. Never use a cylinder that cannot be positively identified. Color coding is not a reliable way of identifying a cylinder because the colors can vary from supplier to supplier.
5. Do not use oil or grease on any cylinder component of an oxidizing gas because a fire or explosion can result.
6. Never transfer gases from one cylinder to another. The gas may be incompatible with the residual gas remaining in the cylinder or may be incompatible with the cylinder material.
7. Never completely empty cylinders during lab operations; rather, leave approximately 25 PSI of pressure. This will prevent any residual gas in the cylinder from becoming contaminated. However, if the cylinder is non-returnable, call OEHS

Hazardous Materials Division chemists for instructions. If inert, you will be asked to vent the remainder of the gas; if not inert, you may need to react it off. In either of these cases, OEHS will be able to discard the cylinder (after valve removal) at no cost to The University. If venting or reacting is unsafe, OEHS can still dispose of most cylinders.

8. Place all cylinders so that the main valve is always accessible.
9. Close the main cylinder valve whenever the cylinder is not in use.
10. Remove regulators from unused cylinders and always put the safety cap in place to protect the valve.
11. Always secure cylinders, whether empty or full, to prevent them from falling over and damaging the valve (or falling on your foot). Secure cylinders by chaining or strapping them to a wall, lab bench, or other fixed support.
12. Oxygen should be stored in an area that is at least 20 feet away from any flammable or combustible materials or separated from them by a non-combustible barrier at least 5 feet high and having a fire-resistance rating of at least 1/2 hour.
13. To transport a cylinder, put on the safety cap and strap the cylinder to a handtruck in an upright position. Never roll a cylinder.
14. Always clearly mark empty cylinders and store them separately.
15. Be careful while handling compressed gas cylinders and never drop or strike a cylinder against anything.
16. Use only wrenches or other tools supplied by the cylinder supplier to open a valve. Open cylinder valves slowly.
17. Only compatible gases should be stored together in a gas cylinder cabinet.
18. Flammable gases must be stored in properly labelled, secured areas away from possible ignition sources and kept separate from oxidizing gases.
19. Do not store compressed gas cylinders in areas where the temperature can exceed 125F.

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F. Biological Hazards and Control

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

1. Recommended Laboratory Practices

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

Contact with skin or mucus membranes:
Spilled material can come into direct contact with the skin as can droplets produced by pipetting, removal of screw caps, and vortex mixing of unsealed tubes.

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

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

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

Inhalation:
It is generally known that aerosols are the primary means by which infectious diseases are spread and contracted. An aerosol can 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 of time and can spread wide distances, especially after entering the ventilation system. Particles with a diameter larger than five microns tend to settle rapidly and can contaminate the skin or other surfaces.

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

The control of 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 3 of this chapter for additional information regarding Laboratory Equipment.

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

The control of an inoculation hazard is accomplished by the safe use, handling, and storage of needles and other sharps. After using a needle, do not recap, 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 recapping it. The needle and other sharps should simply be placed into a sharps container to prevent any injuries. Call the OEHS Hazardous Materials Division at 471-3511 for sharps containers.

2. Biosafety Levels

The Centers for Disease Control (CDC) and the National Institutes of Health (NIH) have developed standard procedures providing protection against biological hazards. The publication *Biosafety in Microbiological and Biomedical Laboratories* provides specific descriptions of combinations of microbiological practices, laboratory facilities, and safety equipment, and recommends their use in four biosafety levels of operation with infectious agents. These biosafety levels are described below.

The biosafety levels described in the *NIH Guidelines for Research Involving rDNA Molecules* 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 lab. BSL1 is for work with agents that pose the least hazard and BSL4 is for work with agents that pose the greatest hazard. Only BSL1 through 3 are included here because there are not any BSL4 labs at The University. Included are examples of organisms which fall within a particular biosafety level. Keep in mind that the biosafety level used for a particular organism may change based on the procedures being performed and the amount of cultures involved.

All work with microbiological agents at The University should follow the CDC/NIH guidelines. Research labs conducting work with microbiological agents should, at a minimum, follow the guidelines for BSL2. Instructional labs working with microbiological agents must always follow the BSL1 guidelines at a minimum. If you are uncertain at which biosafety level your work should be performed, call the OEHS Hazardous Materials Division at 471-3511 for assistance.

Biosafety Level 1
BSL1 is suitable for work involving well-characterized agents not known to cause disease in healthy

adult humans, and of minimal potential hazard to laboratory personnel and the environment.

Examples of BSL1 Agents:

Bacillus subtilus
Naegleria gruberi
Infectious Canine Hepatitis Virus

The laboratory is not necessarily separated from the general traffic patterns in the building. Work is generally conducted on open bench tops using standard microbiological practices. Special containment equipment or facility design is not required nor generally used. Laboratory personnel have specific training in the procedures conducted in the laboratory and are supervised by a scientist with general training in microbiology or a related science. The following standard and special practices, safety equipment, and facilities apply to agents assigned to BSL1:

Standard Microbiological Practices (BSL1)

1. Access to the laboratory is limited or restricted at the discretion of the laboratory director when experiments or work with cultures and specimens is in progress.
2. Persons wash their hands after they handle viable materials and animals, after removing gloves, and before leaving the laboratory.
3. Eating, drinking, handling contact lenses, and applying cosmetics are not permitted in work areas where there is reasonable likelihood of exposure to potentially infectious materials. Persons who wear contact lenses in laboratories should also wear goggles or a face shield. Food is stored outside the work area in cabinets or refrigerators labeled and used for this purpose only.
4. Mouth pipetting is prohibited; mechanical pipetting devices are used.
5. All procedures are performed carefully to minimize the creation of splashes or aerosols.
6. Work surfaces are decontaminated at least once a day and after any spill of viable material.
7. 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. This will be accomplished by using the containers provided by OEHS.
8. An insect and rodent control program is in effect.

Special Practices (BSL1):

None.

Safety Equipment (Primary Barriers) (BSL1):

1. Special containment devices or equipment such as a biological safety cabinet are generally not required for manipulations of agents assigned to BSL1.

2. It is recommended that laboratory coats, gowns, or uniforms be worn to prevent contamination or soiling of street clothes.
3. Gloves should be worn if the skin on the hands is broken or if a rash exists.
4. Protective eyewear should be worn for anticipated splashes of microorganisms or other hazardous materials to the face.

Laboratory Facilities (Secondary Barriers) (BSL1):

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

Biosafety Level 2
BSL2 is similar to Level 1 and is suitable for work involving agents of moderate potential hazard to personnel and the environment.

Examples of BSL2 Agents:

Bordetella pertussis	*Cryptococcus neoformans*
Clostridium tetani	*Mycobacterium leprae*
Shigella spp.	*Human Immunodeficiency Virus*
Human blood	

It *differs* in that (1) laboratory personnel have specific training in handling pathogenic agents and are directed by scientists, (2) access to the laboratory is limited when work is being conducted, (3) extreme precautions are taken with contaminated sharp items, and (4) certain procedures in which infectious aerosols or splashes may be created are conducted in biological safety cabinets or other physical containment equipment. *In addition to all the requirements for BSL1*, work at BSL2 requires:

Special Practices (BSL2):

1. Access to the laboratory is limited or restricted by the laboratory director when work with infectious agents is in progress. In general, persons who are at increased risk of acquiring infection or for whom infection may be unusually hazardous are not allowed in the laboratory or animal rooms. For example, persons who are immunocompromised or immunosuppressed may be at risk of acquiring infections. The laboratory director has final responsibility for assessing each circumstance and determining who may enter or work in the laboratory.
2. The laboratory director establishes policies and procedures whereby only persons who have been advised of the potential hazard and meet specific entry requirements (e.g., immunization) enter the laboratory or animal rooms.
3. When the infectious agent(s) in use in the laboratory require special provisions for entry (e.g., immunization), a hazard warning sign incorporating the universal biohazard symbol is posted on the access door to the laboratory work area. The hazard warning sign identifies the infectious agent, lists the name and telephone number of the laboratory director or other responsible person(s), and indicates the special requirement(s) for entering the laboratory.
4. Laboratory personnel receive appropriate immunizations or tests for the agents handled or potentially present in the laboratory (e.g., hepatitis B vaccine or TB skin testing).
5. When appropriate, baseline serum samples for laboratory and other at-risk personnel are collected and stored. Additional serum specimens may be collected periodically, depending on the agents handled or the function of the facility.
6. A site-specific biosafety manual is prepared or adopted in addition to this Laboratory Safety manual. Personnel are advised of special hazards and are required to read and follow instructions on practices and procedures.

7. Laboratory personnel receive appropriate training on the potential hazards associated with the work involved, the necessary precautions to prevent exposures, and the exposure evaluation procedures. Personnel receive annual updates, or additional training as necessary for procedural or policy changes.

8. A high degree of precaution must always be taken with any contaminated sharp item, including needles and syringes, slides, pipettes, capillary tubes, and scalpels. Needles and syringes or other sharp instruments should be restricted for use only when there is no alternative, such as parenteral injection, phlebotomy, or aspiration of fluids from laboratory animals and diaphragm bottles. Plasticware should be substituted for glassware whenever possible.

    a. Only needle-locking syringes or disposable syringe-needle units (i.e., needle is integral to the syringe) are used for the injection or aspiration of infectious materials. Used disposable needles must not be bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal; rather, they must be carefully placed in conveniently located puncture-resistant containers used for sharps disposal.

       These sharps containers are provided and removed by OEHS. Non-disposable sharps must be placed in a hard-walled container for transport to a processing area for decontamination, preferably by autoclaving.

    b. Syringes that resheathe the needle, needle-less systems, and other safe devices should be used when appropriate.

    c. Broken glassware must not be handled directly by hand, but must be removed by mechanical means such as a brush and dustpan, tongs, or forceps.

9. Cultures, tissues, or specimens of body fluids are placed in a container that prevents leakage during collection, handling, processing, storage, transport, or shipping.

10. Laboratory equipment and work surfaces should be decontaminated with an appropriate disinfectant on a routine basis, after work with infectious materials is finished, and especially after overt spills, splashes, or other contamination by infectious materials. Contaminated equipment must be decontaminated according to any local, state, or federal regulations before it is sent for repair or maintenance or packaged for transport in accordance with applicable local, state, or federal regulations, before removal from the facility.

11. Spills and accidents which result in overt exposures to infectious materials are immediately reported to the laboratory director. Medical evaluation, surveillance, and treatment are provided as appropriate and written records are maintained (see Medical Program, Chapter C.4 of this manual).

12. Animals not involved in work being performed are not permitted in the laboratory.

<u>Safety Equipment (Primary Barriers) (BSL2):</u>

1. Properly maintained biological safety cabinets, preferably Class II, or other appropriate personal protective equipment or physical containment devices are used whenever:

a. Procedures with a potential for creating infectious aerosols or splashes are conducted. These include centrifuging, grinding, blending, vigorous shaking or mixing, sonic disruption, opening containers of infectious materials whose internal pressures may be different from ambient pressures, inoculating animals intranasally, and harvesting infected tissues from animals or eggs.

b. High concentrations or large volumes of infectious agents are used. Such materials may be centrifuged in the open laboratory if sealed rotor heads or centrifuge safety cups are used, and if these rotors or safety cups are opened only in a biological safety cabinet.

2. Face protection (goggles, mask, 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.

3. Protective laboratory coats, gowns, smocks, or uniforms designated for lab use are worn while in the laboratory. This protective clothing is removed and left in the laboratory before leaving for non-laboratory areas (e.g., cafeteria, library, administrative offices). All protective clothing is either disposed of in the laboratory or laundered by the institution; it should never be taken home by personnel.

4. Gloves are worn when handling infected animals and when hands may contact infectious materials, contaminated surfaces, or equipment. Wearing two pairs of gloves may be appropriate; if a spill or splatter occurs, the hand will be protected after the contaminated glove is removed. Gloves are disposed of when contaminated, removed when work with infectious materials is completed, and are not worn outside the laboratory. Disposable gloves are not washed or reused.

Laboratory Facilities (Secondary Barriers) (BSL2):

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

2. An eyewash facility is readily available.

Biosafety Level 3
BSL3 is applicable to clinical, diagnostic, teaching, research, or production facilities in which work is done with indigenous or exotic agents that may cause serious or potentially lethal disease as a result of exposure by the inhalation route.

Examples of BSL3 Agents:

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

Laboratory personnel have specific training in handling pathogenic and potentially lethal agents and are supervised by scientists who are experienced in working with these agents.

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

It is recognized that many existing facilities may not have all the facility safeguards recommended for BSL3 (e.g., access zone, sealed penetrations, and directional airflow). In these circumstances, acceptable safety may be achieved for routine or repetitive operations (e.g., diagnostic procedures involving the propagation of an agent for identification, typing, and susceptibility testing) in BSL2 facilities. However, the recommended Standard Microbiological Practices, Special Practices, and Safety Equipment for BSL3 must be rigorously followed. The decision to implement this modification of BSL3 recommendations should be made only by the laboratory director. *In addition to all the requirements for BSL2*, work at BSL3 requires:

Special Practices (BSL3):

1. Laboratory doors are kept closed when experiments are in progress.
2. The laboratory director controls access to the laboratory and restricts access to persons whose presence is required for program or support purposes.
3. The laboratory director is responsible for ensuring that before working with organisms at BSL3, all personnel demonstrate proficiency in standard microbiological practices and techniques, and in the practices and operations specific to the laboratory facility. This might include prior experience in handling human pathogens or cell cultures, or a specific training program provided by the laboratory director or other scientist proficient in safe microbiological practices and techniques.
4. All manipulations involving infectious materials are conducted in biological safety cabinets or other physical containment devices within the containment module. No work in open vessels is conducted on the open bench.
5. All potentially contaminated waste materials (e.g., gloves and lab coats) from laboratories or animal rooms are decontaminated before disposal or reuse.

6. Spills of infectious materials are decontaminated, contained, and cleaned by appropriate professional staff, or others properly trained and equipped to work with concentrated infectious material.

Safety Equipment (Primary Barriers) (BSL3):

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

Laboratory Facilities (Secondary Barriers) (BSL3):

1. The laboratory is separated from areas that are open to unrestricted traffic flow within the building. Passage through two sets of self-closing doors is the basic requirement for entry into the laboratory from access corridors or other contiguous areas. A clothes change room (shower optional) may be included in the passageway.
2. Each laboratory contains a sink for handwashing. The sink is foot, elbow, or automatically operated and is located near the laboratory exit door.
3. The interior surfaces of walls, floors, and ceilings are water-resistant so that they can be easily cleaned. Penetrations in these surfaces are sealed or capable of being sealed to facilitate decontamination.
4. Windows in the laboratory are closed and sealed.
5. A method for decontaminating all laboratory wastes is available, preferably within the laboratory (i.e., autoclave, chemical disinfection, incineration, or other approved decontamination method).
6. A ducted exhaust air ventilation system is provided. This system creates directional airflow that draws air from "clean" areas into the laboratory toward "contaminated" areas. The exhaust air is not recirculated to any other area of the building, and is discharged to the outside with filtration and other treatment optional. The outside

exhaust must be dispersed away from occupied areas and air intakes. Laboratory personnel must verify that the direction of airflow (into the laboratory) is proper.

7. The High Efficiency Particulate Air (HEPA) filtered exhaust air from Class II or Class III biological safety cabinets is discharged directly to the outside or through the building exhaust system. If the HEPA filtered exhaust air from Class II or Class III biological safety cabinets is to be discharged to the outside through the building exhaust air system, it is connected to this system in a manner (e.g., thimble unit connection) that avoids any interference with the air balance of the cabinets or building exhaust system. Exhaust air from Class II biological safety cabinets may be recirculated within the laboratory if the cabinet is tested and certified according to the guidelines included on National Sanitation Foundation Standard 49.
8. Continuous flow centrifuges or other equipment that may produce aerosols are contained in devices that exhaust air through HEPA filters before discharge into the laboratory.
9. Vacuum lines are protected with liquid disinfectant traps and HEPA filters, or their equivalent, which are routinely maintained and replaced as needed.

3. Laboratory Equipment

Biological Safety Cabinets

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

Depending on the design, a BSC may be vented to the outside or the air may be exhausted into the room. BSCs are <u>not</u> 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.

Classes of BSCs

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

Class II
There are different types of Class II BSCs, but they all offer HEPA filtered supply and exhaust air. This type of cabinet will protect the user, environment, and the product and is suitable for work assigned to Biosafety Levels 1, 2, or 3. Class II cabinets are the class most commonly used.

Class III
These cabinets are often referred to as Gloveboxes. The Class III cabinet is gas-tight and under negative pressure. All work in the cabinet is performed through rubber gloves attached to entry portals. The Class III cabinet offers the highest level of protection from infectious aerosols. Class III cabinets are most suitable for work with agents that require BSL3 or BSL4 containment.

Proper Use of BSCs:

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

Certification of BSCs

A BSC must be certified annually and after it has been newly installed, moved, or had a filter replaced. There are several companies in the area which provide this service. For further information, contact the OEHS Hazardous Materials Division at 471-3511.

Clean Benches

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

Pipetting Devices

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

Centrifuges, Sonicators, Homogenizers, and Blenders

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

Centrifuges

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

Routinely inspect your centrifuge to ensure leakage is not occurring. An indicator such as fluorescein can be used to detect leaks. The fluorescein can be added to water and

then centrifuged as you would other materials. An ultraviolet light can then be used to detect the fluorescein's presence on work surfaces, floors, and walls.

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

4. Personal Protective Clothing

The type of personal protective clothing required in microbiological labs will depend upon the assigned Biosafety Level for that lab (see Section 2 of this chapter regarding Biosafety Levels). The protective clothing suitable for a typical undergraduate microbiology lab is a lab coat, to prevent street clothes from getting soiled, and latex or vinyl gloves. Long hair must be restrained if Bunsen burners are in use.

For a typical graduate level teaching or research microbiology lab (which are often a BSL2), lab coats or similar protective clothing should be worn while in the lab, and gloves must be worn while handling any infectious materials. Additionally, if the work involves human blood, a face shield, safety glasses or goggles, and a mask may be required if there is a potential for splash.

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

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

5. Waste Disposal

There are many types of waste generated in a microbiological lab and all need to be handled, treated, stored, and disposed of properly (refer to OEHS Procedures for Disposal of Hazardous Waste manual for more detailed information).

6. Bloodborne Pathogens

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

If during the course of work a potential exists for coming in contact with human blood or other potentially infectious materials, you must receive training on bloodborne pathogens. Contact OEHS, Hazardous Materials Division, at 471-3511 for information regarding Bloodborne Pathogens Training.

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

1. Use appropriate barrier precautions to prevent skin and mucus membrane exposure when contact with blood is anticipated. Always wear gloves. Wear masks and protective eyewear or face shields to prevent exposure to the eyes, mouth, and nose during procedures that are likely to result in droplets of blood. Wear gowns or aprons during procedures that are likely to result in splashes of blood. Remove all protective clothing before leaving the laboratory.
2. Wash hands and other skin surfaces immediately if contaminated with blood and after the removal of gloves.
3. Limit the use of needles to where there is no alternative and take precautions to prevent injuries by needles and other sharps. To prevent needle-stick injuries, needles should not be recapped, bent, removed from the syringe, or otherwise manipulated by hand. Place needles and other sharps into puncture-resistant containers.
4. Keep all specimens of blood in well constructed containers with a secure lid to prevent leakage during transport.
5. Use biological safety cabinets whenever procedures that have a high potential for generating droplets are conducted.
6. Never mouth pipette.
7. Decontaminate laboratory work surfaces after a spill of blood and when work activities are completed.

Some animals can also carry pathogens that can be transmitted to humans through contact with their body fluids, similar to human bloodborne pathogens. This contact can occur through biting, spitting, or contamination of broken skin or mucus membranes with bodily secretions from the animal. An example of a disease transmitted this way is the B-virus infection. B-virus is a naturally occurring alpha-herpes virus infecting macaques. Human infection has been documented in 25 instances, 16 of those resulting in death.

When working with animals such as macaques that are capable of transmitting disease to humans, take necessary precautions to protect yourself. Wear gloves, masks, and laboratory coats whenever entering an area where these animals are housed. Guidelines are available for safely working with macaques and can be obtained by calling OEHS.

7. Emergency Procedures

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

Some biological materials when spilled or released can lead to significant infection exposures of personnel. This is particularly hazardous when the agent spilled or released is classified as a BSL2 agent or higher. The following emergency procedures that must be followed are determined by the Biosafety Level of the agent involved.

Spills or Releases Involving BSL1 Agents:

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

Spills or Releases Involving BSL2 Agents:

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

Spills or Releases Involving BSL3 Agents:

1. If the spill occurs in a biological safety cabinet, keep the cabinet running, and clean the spill following steps two through four from *Spills or Releases Involving BSL2 Agents*, except that personal protective clothing appropriate for a BSL3 lab should be worn. If the spill in the cabinet is quite substantial, it may be necessary to

decontaminate the cabinet's fan, filters, and airflow plenums. This should be done by a qualified outside company. Call the OEHS Biological and Laboratory Safety Coordinator for assistance.

2. If a minor spill occurs outside of a biological safety cabinet, follow steps two through four from *Spills or Releases Involving BSL2 Agents*, except that personal protective clothing appropriate for a BSL3 lab should be worn.

3. If anything other than a minor spill occurs outside of a biological safety cabinet, leave the area immediately and notify appropriate personnel including the OEHS Biological and Laboratory Safety Coordinator. A specially designed decontamination procedure may be necessary.

   Note: Whenever bleach is used to clean up spills of an infectious agent, a fresh solution should be prepared. After about one week, a bleach and water solution will lose its effectiveness for decontamination.

References:

Biosafety in the Laboratory, Prudent Practices for the Handling and Disposal of Infectious Materials. National Research Council. 1989.

Biosafety in Microbiological and Biomedical Laboratories, Third Edition. Centers for Disease Control and National Institutes of Health. 1993.

APPENDICES

Lab Safe Refrigerator

- **Volatile Poisons**:
  Osmium Tetroxide
  Vanadium Pentoxide
- **Malodorous Compounds**:
  Butyl Mercaptan
  Methyl Sulfide
- **Monomers:**
  Styrene
  Methacrylates
- **Peroxide Formers**:
  Diethyl Ether
  Tetrahydrofuran (if not used often)
- **High Reactivity Organometallics**:
  Butyl Lithium
  Piphenylmagnesium

Flammables Storage Cabinet

Liquids or solids with a flashpoint ≤100° F (37.7° C)

- **Alcohols:**
  Isopropyl Alcohol
  Ethanol
- **Ketones:**
  Acetone
  MEK

Acid Cabinet

- **Liquid Inorganic Acids:**
  Hydrocholoric Acid
  Sulphuric Acid

Note: Store Nitric Acid away from other acids unless your acid cabinet provides a separate compartment for Nitric Acid

Organic Acids

- **Acid Chorides:**
  Adipoyl Chloride
  Fumaryl Chloride
  Trichloroacetic Acid

Other Organics:
Phenol
Hydrocarbons and Alcohols

Low Reactivity Organometallics:
Ferrocene
Nicklelocene

Inorganic Bases
Potassium Hydroxide
Sodium Hydroxide (best if stored on lower shelves)

Acid Reactive Inorganics:

- **Cyanides:**
  Potassium Cyanide
- **Sulfides:**
  Ammonium Sulfide

Oxidizers
Potassium Permanganate
Silver Nitrate

Solid Inorganic Acids

- **Metal Chlorides:**
  Ferric Chloride
  Cupric Chloride
- **Phosphoric Pentoxide**

Water Reactives:

- **Metals:**
  Sodium
  Lithium
- **Hydrides:**
  Lithium Aluminum Hydride
  Potassium Hydride

Low Reactivity Inorganics:

- **Inorganic Salts:**
  Calcium Chloride
  Ammonium Bromide

Organic Bases

- **Amines:**
  Triethanolamine
  Dicyclohexylamine

Other Organics:

- **Halogenated Hydrocarbons:**
  Methylene Chloride
  Chloroform
- **Sulfides and Sulfates:**
  DimethylSulfate
  Diethyl Sulfide

Laboratory Safety Self Evaluation

(required each semester)

Department: _____ Building: _____
Principal Investigator: _____ Room(s): _____
Date: _____ Contact: _____ PH#: _____

S = Satisfactory N = Needs Improvement N/A = Not Applicable

The items in this section are required to ensure regulatory compliance.

S N N/A

Chemical Waste

Containment and Storage

__ __ __ 1. All containers are closed unless actively receiving waste.
__ __ __ 2. No containers are leaking.
__ __ __ 3. All containers are compatible with their contents.
__ __ __ 4. No waste is poured down the drain without prior approval by the Waste Management Section of OEHS.
__ __ __ 5. The location of waste pick-up is in the immediate vicinity of point of generation and under supervision of person who generated it.
__ __ __ 6. Less than a total of one quart of acutely hazardous waste is present.
__ __ __ 7. Less than a total of 55 gallons of possibly hazardous waste is present.

Labeling

__ __ __ 1. All containers are labeled with the words "waste" or "spent" and their contents are identified.
__ __ __ 2. No containers are labeled with the words "hazardous" or "non-hazardous."

Disposal

__ __ __ 1. Each waste container that is ready for disposal has a properly filled out waste tag attached to it.
__ __ __ 2. For containers ready for disposal a properly filled out pick-up request form has been forwarded to OEHS. Both the tags and pick-up request forms are available through OEHS at 471-3511.

Special Waste

Sharps

__ __ __ 1. All sharps are deposited into red sharps containers provided and picked up by OEHS.
__ __ __ 2. Needles are not bent, re-capped, or clipped.

S N N/A

Animals

___ ___ ___ 1. All animals and animal parts are kept frozen and double bagged until pickup by OEHS or delivery to ARC.

___ ___ ___ 2. Bedding from animals intentionally exposed to pathogens must be treated in the lab, e.g., autoclaved, or picked up by OEHS.

Pathological Waste and Blood and Blood Products

___ ___ ___ 1. All must either be treated in the lab, e.g., autoclaved, or picked up by OEHS.

Microbiological Waste

___ ___ ___ 1. All microbiological waste must either be treated in the lab, e.g., autoclaved, or picked up by OEHS.

Disposal of Special Waste In the Lab

___ ___ ___ 1. A log is kept of all special waste treated in the lab. Refer to the OEHS Procedures for Disposal of Hazardous Waste manual for details.

___ ___ ___ 2. All labs must have a written procedure for operation and testing of equipment and for the preparation of any chemicals used in treatment.

___ ___ ___ 3. The bag or container of special waste must have a "treated" label and go into another bag of a different color that is also opaque. This bag can then be thrown into the regular trash.

___ ___ ___ 4. The treatment methods used to treat special waste in the lab are in accordance with the OEHS Procedures for Disposal of Hazardous Waste manual.

Radioactive Materials

Labeling

___ ___ ___ 1. The area is posted with "Radiation" or "Radioactive Materials" signs.

___ ___ ___ 2. Radioactive sharps are deposited into puncture resistant, marked containers.

___ ___ ___ 3. Radioactive materials storage units are posted with proper signs.

___ ___ ___ 4. Containers that do not hold radioactive materials are not labeled "radioactive."

Work Area

___ ___ ___ 1. All materials containing isotopes are shielded.

___ ___ ___ 2. Film badges are stored away from isotopes.

___ ___ ___ 3. Isotopes are secured when not attended.

___ ___ ___ 4. Food and drink are not in the lab at any time.

S N N/A

Records

__ __ __ 1. Records of Disposition of isotopes are current.
__ __ __ 2. Film badge records are current, organized, and available.
__ __ __ 3. Quarterly inventory is current and available.

Controlled Substances

Security

__ __ __ 1. Security is adequate to prevent unauthorized use, access, and diversion of controlled substances.
__ __ __ 2. Controlled substances are stored in a locked cabinet.

Records

__ __ __ 1. Records of purchases, acquisition, dispensations, and disposal of controlled substances are kept.

Disposal

__ __ __ 1. Outdated and unused controlled substances are disposed of in accordance with the US Drug Enforcement Agency (DEA) procedures.

Hazard Communication Act

MSDS

__ __ __ 1. MSDS are available and readily accessible for every hazardous chemical present.
__ __ __ 2. Lab personnel know where and how to obtain MSDS. Some MSDS are available on the mainframe computer and at OEHS.

Labels

__ __ __ 1. The labels on incoming chemical containers are not removed or defaced and are maintained as required.
__ __ __ 2. Secondary containers, other than ones for immediate use, are labeled with the identity of their contents.

Training

__ __ __ 1. All lab personnel have had Hazard Communication training.

The items in this section represent well-established safety and health guidelines that should be followed in all laboratories.

S	N	N/A	
			Personal Protective Clothing
___	___	___	1. The appropriate personal protective clothing for work being performed is present and in good condition.
___	___	___	2. Lab personnel wear appropriate personal protective clothing while in the lab.
			Personal Protective Equipment
___	___	___	1. Fume hoods are working properly and only essential items are stored in them.
___	___	___	2. Fume hoods have been tested by OEHS within the past year.
___	___	___	3. The fume hood sash is pulled down as far as is practical.
___	___	___	4. Biological safety cabinets are used properly and are certified on an annual basis.
			Emergency Equipment
___	___	___	1. Emergency showers are available and are unobstructed.
___	___	___	2. Emergency showers have been tested by Physical Plant within the past year.
___	___	___	3. Eyewashes are available, are unobstructed, and are tested weekly by lab personnel to flush impurities through them.
___	___	___	4. Lab personnel are trained in the use of fire extinguishers.
___	___	___	5. *Whenever* a fire extinguisher has been used, the OEHS, Fire Section, is contacted at 471-3511.
			Fire/Life Safety
___	___	___	1. All exits and walkways in the lab are clear and unobstructed.
___	___	___	2. Lab doors are kept closed as much as possible to provide a fire and smoke barrier.
___	___	___	3. The storage of combustibles, e.g., cardboard boxes and paper towels, is minimized.
___	___	___	4. Bunsen burner tubing is checked regularly and any found cracked or brittle is replaced.
___	___	___	5. Vacuum pumps are properly maintained and are stored away from flammable chemicals and combustible material.
			Electrical Safety
___	___	___	1. All electrical cords are in good condition. None have cracked, brittle, or frayed insulation.
___	___	___	2. All electrical equipment is properly grounded.
___	___	___	3. No electrical/extension cords are run above the ceiling or behind walls.
___	___	___	4. The use of extension cords in the lab is minimized.
___	___	___	5. No electrical cords are run across the floor where they could be a tripping hazard.

S N N/A

Chemical Storage

___ ___ ___ 1. All chemicals are stored by hazard class, e.g., flammables, oxidizers, acids, bases, reactives, and toxins.
___ ___ ___ 2. No breakable chemical containers are stored on the floor.
___ ___ ___ 3. All chemical containers are kept closed.
___ ___ ___ 4. No hazardous chemicals are stored above eye level.
___ ___ ___ 5. Flammables stored in the lab are minimized and are kept in flammable storage cabinets.
___ ___ ___ 6. Flammables are never stored in standard household refrigerators.
___ ___ ___ 7. Chemicals are dated when received and opened.
___ ___ ___ 8. The integrity of chemical containers and labels are checked regularly.
___ ___ ___ 9. Compressed gas cylinders are secured and the safety cap is in place.
___ ___ ___ 10. Hazardous gases are used only in fume hoods.

Physical Hazards

___ ___ ___ 1. All belt driven vacuum pumps are protected with belt guards.
___ ___ ___ 2. All fans are guarded.
___ ___ ___ 3. Glassware used at pressures other than ambient are taped or shielded.
___ ___ ___ 4. Glassware for disposal is deposited into puncture resistant buckets which are provided by and picked up by Custodial Services.

Radioactive Materials

___ ___ ___ 1. Radioactive waste is kept in only one marked area.
___ ___ ___ 2. Radioactive materials records are kept in a separate book.
___ ___ ___ 3. Film badges are worn whenever using isotopes.

Spill Control

___ ___ ___ 1. Spill control materials are available.
___ ___ ___ 2. Lab personnel are trained in spill clean up procedures.

Hazardous Chemical Inventory Instruction Sheet

On the inventory form, please indicate both the **typical quantities** (**TQ**) and **maximum quantities** (**MQ**) for each of the following types of materials that are stored in your laboratory. (Please specify quantities only in the units indicated. An approximate conversion from metric units is acceptable (e.g., 4 liters = 1 gallon). A precise definition for each type of material is given in italics, along with some examples. Please call the OEHS Hazardous Materials Division at 471-3511 with any questions regarding completion of the inventory form.

Explosives

Materials that may cause a sudden, almost instantaneous release of pressure, gas, and/or heat when subjected to sudden shock, pressure, or elevated temperatures. Examples include dry picric acid, nitroglycerin, lead azide, 2,4-dinitrophenylhydrazine, peracetic acid, sodium acetylide, mercury fulminate, nitrogen triiodide, diazomethane, and ruthenium perchlorate.

Pyrophoric Materials

Materials that will spontaneously ignite in air at or below a temperature of 130˚F (54.4˚C). Examples include organomagnesiums, methyl phosphonous dichloride, dimethylzinc, organolithiums, and diethyl chlorophosphite.

Flammable Solids

Materials that do not meet the definition of explosives that are prone to cause fire through friction or some other physical means, that have an ignition temperature below 212˚F (100˚C), or which burn so vigorously and/or persistently when ignited that they create a considerable hazard. Flammable solids include finely divided solid materials which when dispersed in air as a cloud may be ignited, thereby causing an explosion. Examples include powdered magnesium, phosphorus trisulfide, palladium on carbon, white phosphorus, and nitrocellulose.

Flammable Liquids

Flammable liquids are those liquids having a flash point below 100˚F (37.8˚C) at atmospheric pressure and having a vapor pressure not exceeding 40 psi (2.72 atmospheres) at room temperature. Examples of flammable liquids that are miscible with water include isopropyl alcohol, isopropylamine, methanol, p-dioxane, acetonitrile, acetone, and acetaldehyde. Examples of flammable liquids that are water-insoluble (i.e., *not miscible* with water) include carbon disulfide, *n*-hexane, benzene diethyl ether, and methyl ethyl ketone.

Please inventory water-miscible and water-insoluble flammable liquids separately on the accompanying form.

Combustible Liquids

Combustible liquids are those liquids having a flash point between 100˚F (37.8˚C) and 200˚F (93.3˚C) at atmospheric pressure. Examples of combustible liquids that are miscible with water include dimethyl formamide, dimethyl sulfoxide, and diglyme (diethylene glycol dimethyl ether). Examples of combustible liquids that are water-insoluble include cyclohexanone, aniline, *n*-pentanol, and benzyl chloride.

Please inventory water-miscible and water-insoluble combustible liquids separately on the accompanying form.

Oxidizers

Materials that do not meet the definition of explosives that either initiate or promote combustion in other materials, thereby causing fire either of themselves or through the release of oxygen and/or other gases. Examples include red fuming nitric acid, potassium permanganate, chromium trioxide, hydrogen peroxide, potassium persulfate, and sodium chlorate.

Organic Peroxides

Organic compounds that contain either a peroxide (R_1OOR_2) or a hydroperoxide (ROOH) functionality in their molecular structure. Examples include peroxyacetic acid, cumene hydroperoxide, and benzoyl peroxide.

Water Reactive Materials

Materials which either explode, violently react, evolve flammable, toxic, or otherwise hazardous gases, or evolve enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water or moisture. Examples include lithium aluminum hydride, calcium phosphide, sodium borohydride, phosphorus pentasulfide, and pure alkali metals.

Corrosive Materials

Typical aqueous acids and bases. Examples of acids include hydrochloric acid, sulfuric acid, acetic acid, and perchloric acid. Examples of bases include ammonium hydroxide and aqueous sodium hydroxide.

Please inventory acids and bases separately on the accompanying form.

Extremely Toxic Materials

Materials that pose an unusual hazard or risk due either to the fact that they are lethal or acutely toxic at relatively low concentrations. Examples include ricin, strychnine, sarin, soman (pinacolyl methylphosphonofluoridate), tabun (dimethylamidoethoxyphoshphoryl cyanide) and aconitine.

Cryogenic Fluids

Fluids that have a normal boiling point below 150˚F (65.6˚C) at atmospheric pressure. Examples include liquid helium and liquid nitrogen.

Radioactive Materials

Materials which spontaneously emit ionizing radiation. Examples include ^{14}C, ^{235}U, and ^{3}H compounds.

Simply denote whether or not materials of this nature are present in the lab by circling yes (Y) or no (N) on the inventory form.

Pathogenic Materials

Any bacterial, fungal, parasitic, rickettsial, or viral disease causing agent.

Simply denote whether or not materials of this nature are present in the lab by circling yes (Y) or no (N) on the inventory form.

Compressed Gases

Any material or mixture that, when enclosed in a container, has an absolute pressure exceeding 40 psi at 70˚F (21.1˚C) or, regardless of the pressure at 70˚F, has an absolute pressure greater than 140 psi at 130˚F (54.4˚C). Examples include ethylene oxide, carbon dioxide, and acetylene.

This inventory is intended to address only **three specific types** of compressed gases: **flammable gases** (i.e. materials that ignite either spontaneously or upon exposure to some energy source when released from their container), **gases which pose a significant threat to human health** (i.e. materials which are poisonous and/or have a destructive effect on human tissue), and **reactive gases** (i.e. materials which are oxidizers and/or materials which undergo violent reaction, such as decomposition or polymerization, when released from their container. For the purposes of this worksheet only gases that fit into one of these types should be inventoried. In order to assign the appropriate type for each gas, determine all of the hazard characteristics for a particular gas and assign the highest priority hazard characteristic as the type for that gas. In order of decreasing priority, the three types of compressed gases to be inventoried are:

1. Flammable gases
2. Gases which pose a significant threat to human health
3. Reactive gases

Examples:

1. Phosphine - This gas is flammable and poisonous. Considering the aforementioned prioritization scheme, this gas would only be inventoried as a flammable-type gas.
2. Bromine Chloride - This gas is poisonous, corrosive, and an oxidizer. It would only be inventoried as a gas which poses a significant threat to human health.

Once the hazard type for each gas is determined, report the aggregate quantity of each type of gas.

Compressed Gas Reference Table

Compressed Gas	Hazard Characteristic
Acetylene	Flammable
Air	None
Allene	Flammable
Ammonia	Reactive
Argon	None
Arsine	Health Threat
Arsenic Pentafluoride	Reactive
Boron Trichloride	Reactive
Boron Trifluoride	Health Threat
Bromine Pentafluoride	Health Threat
Bromine Trifluoride	Health Threat
Bromoacetone	Health Threat
Bromotrifluoroethylene	Health Threat
Bromotrifluoromethane	Health Threat
1,3-Butadiene	Flammable
Butane	Flammable
1-Butene	Flammable
2-Butene	Flammable
Carbon Dioxide	None
Carbon Monoxide	Flammable
Carbonyl Fluoride	Health Threat
Carbonyl Sulfide	Flammable
Chlorine	Health Threat
Chlorine Pentafluoride	Health Threat
Chlorine Trifluoride	Health Threat
Chlorodifluoroethane	Flammable
Compressed Gas	**Hazard Characteristic**
Chlorodifluoromethane	None
Chlorofluoromethane	None
Chloroheptafluorocyclobutane	Health Threat
Chloropentafluoroethane	None
1-Chloro-1,2,2,2-Tetrafluoroethane	None
1-Chloro-2,2,2-Trifluoroethane	None

Chlorotrifluoroethylene	None
Chlorotrifluoromethane	None
Cyanogen	Health Threat
Cyanogen Chloride	Health Threat
Cyclopropane	Flammable
Deuterium	Flammable
Deuterium Chloride	Health Threat
Deuterium Fluoride	Health Threat
Deuterium Selenide	Health Threat
Deuterium Sulfide	Flammable
Diborane	Flammable
Dichlordifluoromethane	None
1,2-Dichlorohexafluorocyclobutane	Health Threat
Dichlorosilane	Flammable
1,1-Dichlortetrafluoroethane	None
2,2-Dichloro-1,1,1-Trifluoroethane	None
Diethylzinc	Flammable
1,1-Difluoroethane	Flammable
1,1-Difluoroethylene	Flammable
Dimethylamine	Flammable
Dimethyl Ether	Flammable
Dimethyl Silane	Flammable
2,2-Dimethylpropane	Flammable
Diphosgene	Health Threat
Ethane	Flammable
Ethylacetylene	Flammable
Ethylamine	Flammable
Ethyl Chloride	Flammable
Compressed Gas	**Hazard Characteristic**
Ethyldichloroarsine	Health Threat
Ethylene	Flammable
Ethylene Oxide	Flammable
Ethyl Fluoride	Flammable
Fluorine	Health Threat
Germane	Health Threat
Helium	None
Heptafluorobutyronitrile	Health Threat
Hexafluoroacetone	Health Threat
Hexafluorocyclobutene	Health Threat
Hexafluoroethane	None
Hexafluoropropylene	None
Hydrogen	Flammable

Hydrogen Bromide	Health Threat
Hydrogen Chloride	Health Threat
Hydrogen cyanide	Flammable
Hydrogen Iodide	Health Threat
Hydrogen Selenide	Health Threat
Hydrogen Sulfide	Flammable
Iodine Pentafluoride	Health Threat
Isobutane	Flammable
Isobutylene	Flammable
Krypton	None
Lewisite (β-chlorovinyldichloroarsine)	Health Threat
Methane	Flammable
Methylacetylene	Flammable
Methyl bromide	Flammable
3-Methyl-1-butene	Flammable
Methyl Chloride	Flammable
Methyldichloroarsine	Health Threat
Methyl Fluoride	Flammable
Methylene Fluoride	None
Methanethiol	Flammable
Methylsilane	Flammable
Compressed Gas	**Hazard Characteristic**
Methylamine	Flammable
Natural Gas	Flammable
Neon	None
Nickel Carbonyl	Flammable
Nitric Oxide	Health Threat
Nitrogen	None
Nitrogen Dioxide	Health Threat
Nitrogen Trifluoride	Health Threat
Nitrogen trioxide	Health Threat
Nitrosyl Chloride	Health Threat
Nitrosyl Fluoride	Health Threat
Nitrous Oxide	None
Nitryl Fluoride	Health Threat
Octafluorocyclobutane	None
Octafluoropropane	None
Oxygen	Health Threat
Oxygen Difluoride	Health Threat
Pentaborane	Flammable
Pentafluoropropionitrile	Health Threat
Perchloryl Fluoride	Health Threat

Perfluorobutane	None
Perfluoro-2-butene	None
Phenylcarbylamine Chloride	Health Threat
Phosgene	Health Threat
Phosphine	Flammable
Phosphorus Pentafluoride	Health Threat
Phosphorus Trifluoride	Health Threat
Propane	Flammable
Propylene	Flammable
Silane	Flammable
Silicon Tetrafluoride	Health Threat
Stibine (Antimony Hydride)	Health Threat
Sulfur Dioxide	Health Threat
Sulfur Hexafluoride	Health Threat
Compressed Gas	**Hazard Characteristic**
Sulfuryl Fluoride	Health Threat
Tetrafluoroethylene	Flammable
Tetrafluorohydrazine	Health Threat
Tetrafluoromethane	Health Threat
Tetramethyl Lead	Flammable
Triethylaluminum	Flammable
Triethylborane	Flammable
Trifluoroacetonitrile	Health Threat
Trifluoroacetyl Chloride	Health Threat
1,1,1-Trifluoroethane	Flammable
Trifluoromethane	None
Trifluoromethyl Hypofluorite	Health Threat
Trifluoromethyl Iodide	Health Threat
Trimethylstibine	Health Threat
Vinyl Chloride	Flammable
Vinyl Fluoride	Flammable
Vinyl Methyl Ether	Flammable
Xenon	None

UT OEHS HazMat

Hazardous Chemical Inventory

Bldg: _____ Room: _____

: _____

Explosives
Typical Quantity _____ pounds
Maximum Quantity _____ pounds

Pyrophoric Materials
Typical Quantity _____ pounds
Maximum Quantity _____ pounds

Flammable Solids
Typical Quantity _____ pounds
Maximum Quantity _____ pounds

Flammable Liquids
I. Miscible in water
Typical Quantity _____ gallons
Maximum Quantity _____ gallons

II. Water-insoluble
Typical Quantity _____ gallons
Maximum Quantity _____ gallons

Combustible Liquids
I. Miscible in water
Typical Quantity _____ gallons
Maximum Quantity _____ gallons

II. Water-insoluble
Typical Quantity _____ gallons
Maximum Quantity _____ gallons

Oxidizers
Typical Quantity _____ pounds
Maximum Quantity _____ pounds

Organic Peroxides
Typical Quantity _____ pounds
Maximum Quantity _____ pounds

Water Reactive Materials
Typical Quantity _____ pounds
Maximum Quantity _____ pounds

Corrosives
Typical Quantity _____ pounds **ACID**
Maximum Quantity _____ pounds **ACID**

Typical Quantity _____ pounds **BASE**
Maximum Quantity _____ pounds **BASE**

Radioactive Materials

☐ **YES** ☐ **NO**

Extremely Toxic Materials
Typical Quantity _____ pounds
Maximum Quantity _____ pounds

Cryogenic Fluids
Typical Quantity _____ gallons
Maximum Quantity _____ gallons

Pathogenic Materials

☐ **YES** ☐ **NO**

Gases
I. Flammable
Typical Quantity _____ cu. ft. ST
Maximum Quantity _____ cu. ft @ STP

II. Threat to Human Health
Typical Quantity _____ cu. ft. @ STP
Maximum Quantity _____ cu. ft. @ STP

III. Reactive
Typical Quantity _____ cu. ft. @ STP
Maximum Quantity _____ cu. ft. @ STP

Emergency Contacts

Primary Contact _____
Office Phone _____
Home Phone _____

Secondary Contact _____
Office Phone _____
Home Phone _____

UT OEHS HazMat Division : 471-7137
UT Police : 9

Material Safety Data Sheets

Since Material Safety Data Sheets (MSDS) are centrally related to the safe handling of hazardous substances, it is imperative that laboratory workers have easy access to them. At The University, there are four basic means through which MSDS may be acquired:

1. the Chemical Manufacturer
2. the Office of Environmental Health and Safety
3. the UT Mainframe Computer System (UTCAT)

In general, the preferred source for MSDS is the chemical manufacturer, primarily because these files are actively updated to accurately reflect all that is truly known about the hazardous material in question. Other sources include OEHS, which has extensive files MSDS for practically every chemical purchased by The University, and UTCAT, which features an on-line database of MSDS for every chemical marketed by Sigma-Aldrich, Inc. (see Appendix V for instructions regarding retrieval of MSDS from UTCAT on the administrative mainframe).

MSDS are the cornerstone of chemical hazard communication. They provide most of the information you should know to work with chemicals safely. The OEHS is able to provide MSDS to University personnel who need them. This service is available 24 hours a day, seven days a week, and requested MSDS will be retrieved during the employee's work shift. Material Safety Data Sheets are also available on the University mainframe computer for many chemicals and by hardcopy in OEHS files. Because MSDS are so important they will be discussed in further detail. The following information is normally contained in a MSDS:

Product Name and Identification

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

Hazardous Ingredients/Identify Information

1. Hazardous ingredients: substances which, in sufficient concentration, can produce physical or acute or chronic health hazards to persons exposed to the product. Physical hazards include fire, explosions, corrosion, and projectiles. Health hazards include any health effect, even including irritation or development of allergies.
2. TLV: refers to the Threshold Limit Value. A TLV is the highest airborne concentration of a substance to which nearly all adults can be repeatedly exposed, day after day, without experiencing adverse effects. These are usually based on an eight hour time weighted average.

3. PEL: refers to the Permissible Exposure Limit. The PEL is an exposure limit established by OSHA.
4. STEL: refers to the Short Term Exposure Limit. The STEL is a 15 minute time-weighted average exposure which should not be exceeded at any time during a workday. A STEL exposure should not occur more than four times per day and there should be at least 60 minutes between exposures.
5. LD_{50} (lethal dose 50): lethal single dose (usually oral) in mg/kg (milligrams of chemical per kilogram of animal body weight) of a chemical that results in the death of 50% of a test animal population.
6. LC_{50} (lethal concentration 50): concentration dose expressed in ppm for gases or micrograms of material per liter of air for dusts or mists that results in the death of 50% of a test animal population administered in one exposure.

Physical/Chemical Characteristics

Boiling point, vapor pressure, vapor density, specific gravity, melting point, appearance, and odor; all provide useful information about the chemical. Boiling point and vapor pressure provide a good indication of the volatility of a material. Vapor density indicates whether vapors will sink, rise, or disperse throughout the area. The further the values are from one (the value assigned to atmospheric air), the faster the vapors will sink or rise.

Fire and Explosion Hazard Data

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

Reactivity Data

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

release of energy, caused by the material reacting with itself.

Health Hazard Data

1. *Routes of Entry:*
   Inhalation - breathing in of a gas, vapor, fume, mist, or dust.

   Skin absorption - a possible significant contribution to overall chemical exposure by way of absorption through the skin, mucous membranes, and eyes by direct or airborne contact.

   Ingestion - the taking up of a substance through the mouth.

   Injection - having a material penetrate the skin through a cut or by mechanical means.

2. *Health Hazards (acute and chronic):*
   Acute - an adverse effect with symptoms developing rapidly.

   Chronic - an adverse effect that can be the same as an acute effect, except that the symptoms develop slowly over a long period of time or with recurrent exposures.

3. *Carcinogen* - a substance that is determined to be cancer producing or potentially cancer producing.

4. *Signs and Symptoms of Overexposure:*
   The most common symptoms or sensations a person could expect to experience from overexposure to a specific material. It is important to remember that only some symptoms will occur with exposures in most people.

5. *Emergency and First Aid Procedures:*
   Instructions for treatment of a victim of acute inhalation, ingestion, and skin or eye contact with a specific hazardous substance. The victim should be examined by a physician as soon as possible.

Precautions for Safe Handling and Use

1. Spill Clean-up: includes methods to be used to control and clean up spills. Also includes precautions such as to avoid breathing the vapors, avoiding contact with liquids and solids, removing sources of ignition, and other important considerations. May also include special equipment used for the clean-up.

2. Waste Disposal Methods: acceptable and prohibited methods for disposal as well as dangers to the environment.

   Note: These are methods recommended by the chemical manufacturer and are not necessarily in compliance with federal, state, or local regulations. For waste disposal procedures, please refer to the OEHS Procedures for Disposal of Hazardous Waste manual.

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

the MSDS.

Control Measures

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

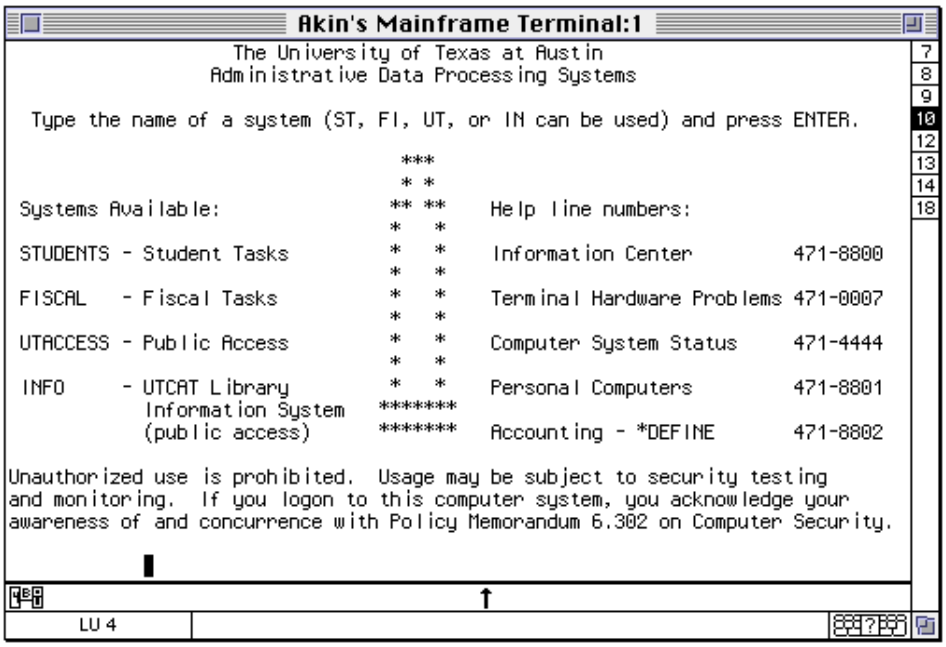
MSDS Retrieval from Mainframe

Retrieving Material Safety Data Sheets from the UT Administrative Computer System:

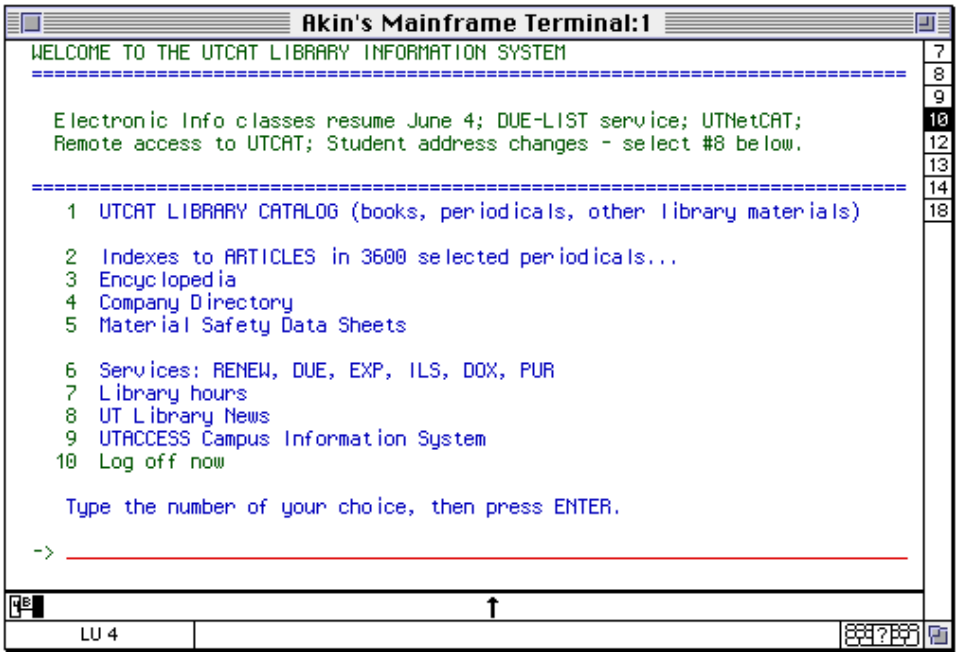
The UT Administrative Computer System (UTCAT) contains material safety data sheets for over 72,000 pure chemical compounds. This MSDS database is searchable by:

- Name,
- Chemical Abstracts Service (CAS) Number, or
- Sigma/Aldrich Product Number.

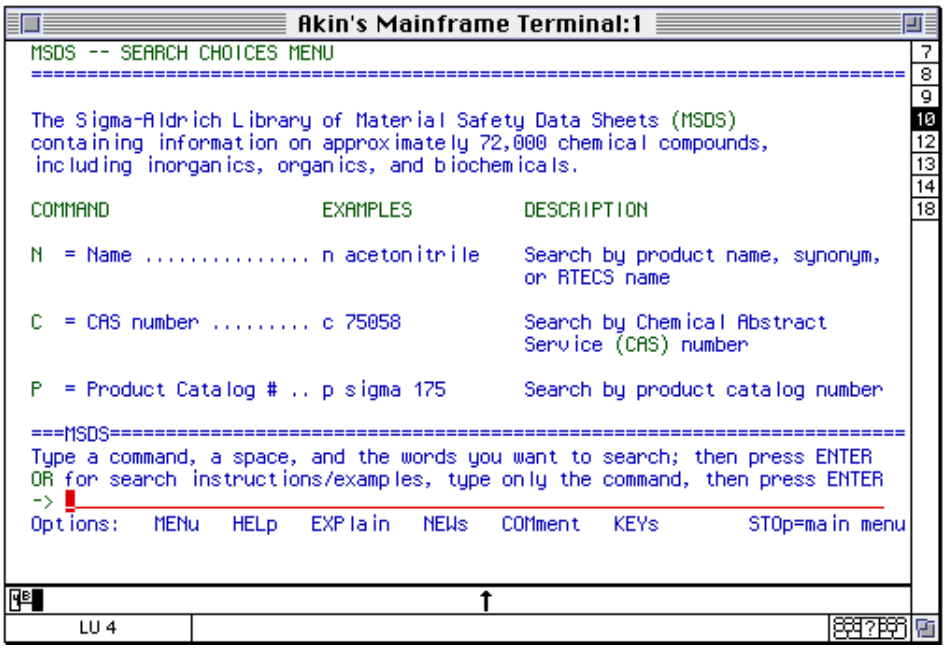
To find a particular MSDS on the UT Administrative Computer System's database, begin at the "tower" screen :



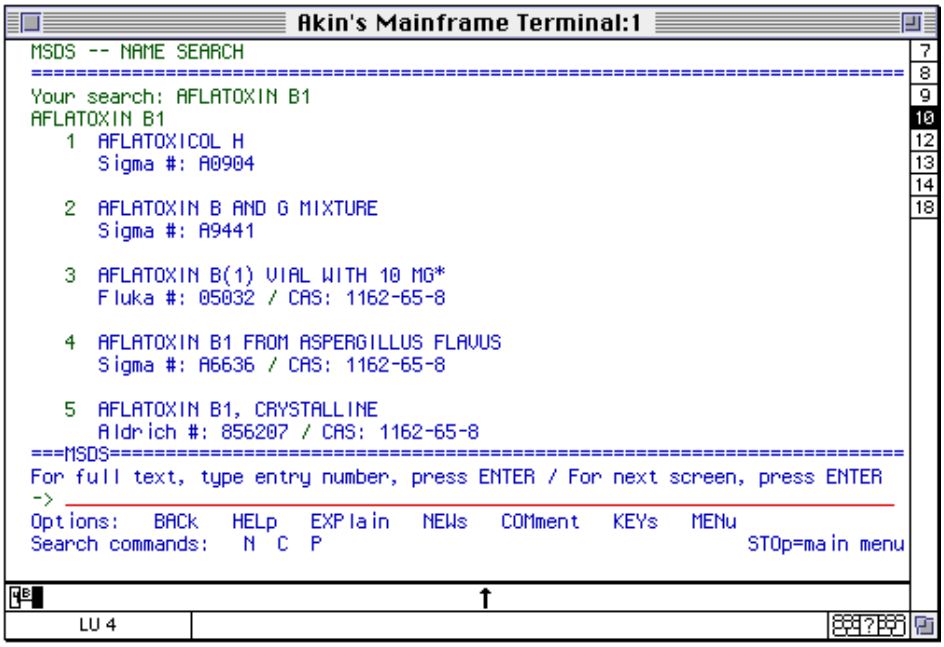
Entering the command INFO (or simply IN) at the tower screen gives you access to the UTCAT PLUS Information System :



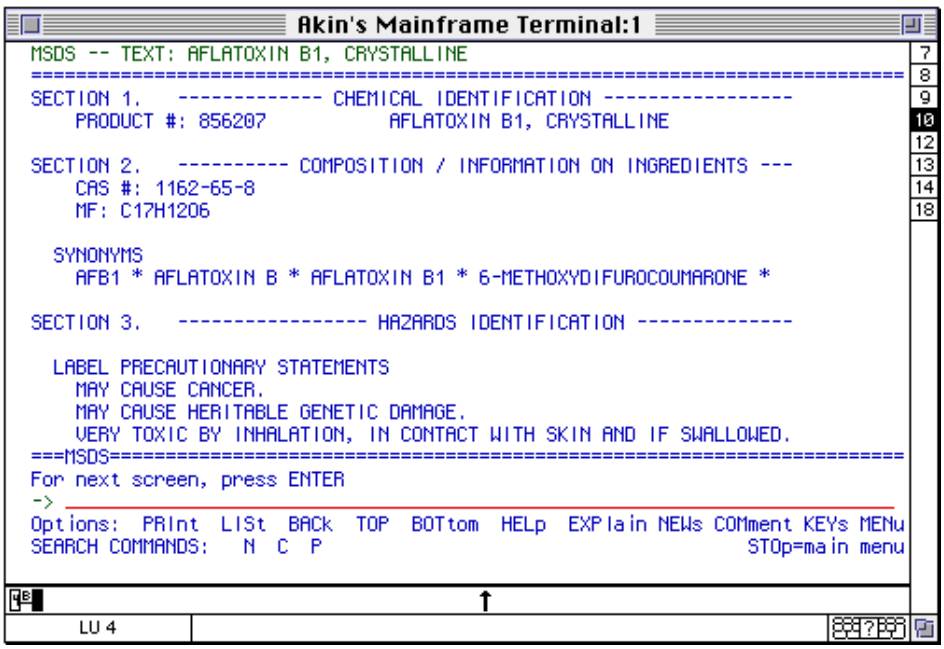
The UTCAT PLUS Information System presents you with a list of options available under UTCAT PLUS. Choosing option 5 will allow you to search the MSDS database:



In the MSDS section, you are presented with three options through which you can search the database - you may search by **name**, by **CAS number**, or by **Sigma/Aldrich product number**. As an example, suppose that you want to look up the MSDS AFLATOXIN B1. To accomplish this, you would simply enter AFLATOXIN B1 on the command line, which will take you to a list of all the material safety data sheets that have been found under this search command:



Entering the number of the MSDS that you are interested in on the command line will present you with the MSDS text:



EMERGENCY INSTRUCTIONS

Is the situation immediately health or life threatening?

YES:

SPILL/ LEAK/ RELEASE

(inc. chem & bio reagents)

- Use safety shower or eyewash - remove affected clothing and rinse for 15 minutes
- Shut doors to the spill area & evacuate the area (if necessary)
- Call Austin Emergency Services at 9-911 (or 911 if **not** a campus phone)
- Contact UTPD at 911
- Contact OEHS at 1-7137 (or 1-2020 after work hours)

MEDICAL EMERGENCY

(**not** inc. chem or bio reagents)

- Administer First Aid while someone calls 9-911 (Austin Emergency Services) from UT phone
- Report the incident to your manager or supervisor
- Contact UTPD at 911
- Contact OEHS at 1-3511 (or 1-2020 after work hours)

FIRE OR FLAMMABLE GAS

- Evacuate the area, if necessary
- Shut doors to the area and alert others
- Pull the nearest fire alarm and call 9-911 from UT phone
- Contact your lab director, principal investigator, or departmental administrator
- Contact UTPD at 911
- Contact OEHS at 1-3511 (or 1-2020 after work hours)

NO:

MINOR SPILL/ LEAK/ RELEASE

(inc. chem & BIO reagents)

- Alert your neighbors
- Contact OEHS at 1-7137 for advice or help, if needed
- Follow steps in Lab Safety Manual or in spill kit

MEDICAL INCIDENT

(**not** inc. chem or bio reagents)

- Administer First Aid to victim
- Report the incident to your lab director or principal investigator
- Contact OEHS at 1-3511 (or 1-2020 after work hours)

FIRE

- Use extinguisher as appropriate for fire
- Contact OEHS at 1-3511 (or 1-2020 after work hours)

NOT SURE?

ODD ODOR?

- Report the incident to your lab director, principal investigator, or department administrator
- Contact OEHS at 1-7137
- Stay in area to inform OEHS response personnel

POSSIBLE FIRE?

- Report the incident to your lab director, principal investigator, or department administrator
- Contact OEHS at 1-3511 (or 1-2020 after work hours)
- Stay in area to inform OEHS response personnel

Prepared by The University of Texas at Austin
Office of Environmental Health and Safety
Hazardous Materials Division - 471-7137

29 CFR 1910.1450
OCCUPATIONAL EXPOSURE TO HAZARDOUS CHEMICALS IN LABORATORIES

(a) Scope and Application

(1) This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.
(2) Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:
  (i) For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.
  (ii) Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.
  (iii) Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.
(3) This section shall not apply to:
  (i) Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart 2, even if such use occurs ina laboratory.
  (ii) Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:
    (A) Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and
    (B) Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

(b) Definitions

"Action level" means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

"Assistant Secretary" means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee. "Carcinogen" (see "select carcinogen").

"Chemical Hygiene Officer" means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

"Chemical Hygiene Plan" means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that
(i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and
(ii) meets the requirements of paragraph (e) of this section.

"Combustible liquid" means any liquid having a flashpoint at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3 deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

"Compressed gas" means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or

(ii) A gas or mixture of gases having, in a container, an absolutepressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

"Designated area" means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, such as a laboratory hood.

"Emergency" means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

"Employee" means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

"Explosive" means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

"Flammable" means a chemical that falls into one of the following categories:

(i) "Aerosol, flammable" means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) "Gas, flammable" means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) "Liquid, flammable" means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) "Solid, flammable" means a solid, other than a blasting agent or explosive as defined in 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A chemical shall be considered to

be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

"Flashpoint" means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z11.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z11.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)). Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

"Hazardous chemical" means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes. Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

"Laboratory" means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

"Laboratory scale" means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

"Laboratory-type hood" means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms. Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the

exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

"Laboratory use of hazardous chemicals" means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"
(ii) Multiple chemical procedures or chemicals are used;
(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and
(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

"Medical consultation" means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

"Organic peroxide" means an organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

"Oxidizer" means a chemical other than a blasting agent or explosive as defined in 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

"Physical hazard" means a chemical for which there is scientifically valid evidence tat it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable (reactive) or water-reactive.

"Protective laboratory practices and equipment" means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

"Reproductive toxins" means chemicals which affect the reproductive chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

"Select carcinogen" means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or
(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or
(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or
(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor

incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.

"Unstable (reactive)" means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

"Water-reactive" means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

(c) Permissible Exposure Limits

For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

(d) Employee Exposure Determination

(1) Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

(2) Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

(3) Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.

(4) Employee notification of monitoring results. The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

(e) Chemical Hygiene Plan

General. (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan).

(1) Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:
   (i) Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and
   (ii) Capable of keeping exposures below the limits specified in paragraph (c) of this section.
(2) The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.
(3) The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;
   (i) Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;
   (ii) Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;
   (iii) A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;
   (iv) Provisions for employee information and training as prescribed in paragraph (f) of this section;
   (v) The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;
   (vi) Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;
   (vii) Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer, and, if appropriate, establishment of a Chemical Hygiene Committee; and
   (viii) Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:
      (A) Establishment of a designated area;
      (B) Use of containment devices such as fume hoods or glove boxes;

(C) Procedures for safe removal of contaminated waste; and
(D) Decontamination procedures.

(4) The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

(f) Employee Information and Training

(1) The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

(2) Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

(3) Information. Employees shall be informed of:

(i) The contents of this standard and its appendices which shall be made available to employees;

(ii) The location and availability of the employer's Chemical Hygiene Plan;

(iii) The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

(iv) Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

(v) The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.

(4) Training.

(i) Employee training shall include:

(A) Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

(B) The physical and health hazards of chemicals in the work area; and

(C) The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

(ii) The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

(g) Medical Consultation and Medical Examinations

(1) The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

(i) Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

(ii) Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

(iii) Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

(2) All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

(3) Information provided to the physician. The employer shall provide the following information to the physician:

(i) The identity of the hazardous chemical(s) to which the employee may have been exposed;

(ii) A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

(iii) A description of the signs and symptoms of exposure that the employee is experiencing, if any.

(4) Physician's written opinion

(i) For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

(A) Any recommendation for further medical follow-up;

(B) The results of the medical examination and any associated tests;

(C) Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and

(D) A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

(ii) The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

(h) Hazard Identification

(1) With respect to labels and material safety data sheets:
  (i) Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.
  (ii) Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

(2) The following provisions shall apply to chemical substances developed in the laboratory:
  (i) If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.
  (ii) If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.
  (iii) If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.120) including the requirements for preparation of material safety data sheets and labeling.

(i) Use of Respirators

Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

(j) Recordkeeping

(1) The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.
(2) The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.1020.

(k) Dates

(1) Effective date. This section shall become effective May 1, 1990.
(2) Start-up dates
  (i) Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.
  (ii) Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

(l) Appendices

1910.1450 Appendix A - National Research Council Recommendations Concerning Chemical Hygiene in Laboratories (Non-Mandatory)

The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

Table of Contents

E. General Procedures for Working With Chemicals

1. General Rules for all Laboratory Work with Chemicals
2. Allergens and Embryotoxins
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4. Chemicals of High Chronic Toxicity
5. Animal Work with Chemicals of High Chronic Toxicity

F. Safety Recommendations

G. Material Safety Data Sheets

Foreword

As guidance for each employer's development of an appropriate laboratory Chemical Hygiene Plan, the following non-mandatory recommendations are provided. They were extracted form "Prudent Practices" for Handling Hazardous Chemicals in Laboratories" (referred to below as "Prudent Practices"), which was published in 1981 by the National Research Council and is available from the National Academy Press, 2101 Constitution Ave., NW,. Washington DC 20418.

"Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here will modify any requirements of the laboratory standard. This Appendix merely presents pertinent recommendations from "Prudent Practices", organized into a form convenient for quick reference during operation of a laboratory facility and during development and application of a Chemical Hygiene Plan. Users of this appendix should consult "Prudent Practices" for a more extended presentation and justification for each recommendation.

"Prudent Practices" deal with both safety and chemical hazards while the laboratory standard is concerned primarily with chemical hazards. Therefore, only those recommendations directed primarily toward control of toxic exposures are cited in this appendix, with the term "chemical Hygiene" being substituted for the word "safety". However, since conditions producing or threatening physical injury often pose toxic risks as well, page references concerning major categories of safety hazards in the laboratory are given in section F.

The recommendations from "Prudent Practices" have been paraphrased, combined, or otherwise reorganized, and headings have been added. However, their sense has not been changed.

Corresponding Sections of the Standard and this Appendix

The following table is given for the convenience of those who are developing a Chemical Hygiene Plan which will satisfy the requirements of paragraph (e) of the standard. It indicates those sections of this appendix which are most pertinent to each of the sections of paragraph (e) and related paragraphs.

Paragraph and Topic in Laboratory Standard		Relevant Appendix Section
(e)(3)(i)	Standard operating procedures for handling toxic chemicals	C, D, E
(e)(3)(ii)	Criteria to be used for implementation of measures to reduce exposures	D
(e)(3)(iii)	Fume hood performance	C4b
(e)(3)(iv)	Employee information and training (including emergency procedures)	D10, D9
(e)(3)(v)	Requirements for prior approval of laboratory activities	E2b, E4b
(e)(3)(vi)	Medical consultation and medical examinations	D5, E4f
(e)(3)(vii)	Chemical hygiene responsibilities	B
(e)(3)(viii)	Special precautions for work with particularly hazardous substances	E2, E3, E4

In this appendix, those recommendations directed primarily at administrators and supervisors are given in sections A-D. Those recommendations of primary concern to employees who are actually handling laboratory chemicals are given in section E. (Reference to page numbers in "Prudent Practices" are given in parentheses.)

A. General Principles for Work with Laboratory Chemicals

In addition to the more detailed recommendations listed below in sections B-E, "Prudent Practices" expresses certain general principles, including the following:

1. It is prudent to minimize all chemical exposures. Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals (2,10). Skin contact with chemicals should be avoided as a cardinal rule (198).

2. Avoid underestimation of risk. Even for substances of no known significant hazard, exposure should be minimized; for work with substances which present special hazards, special precautions should be taken (10, 37, 38). One should assume that any mixture will be more toxic than its most toxic component (30, 103) and that all substances of unknown toxicity are toxic (3, 34).

3. Provide adequate ventilation. The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices (32, 198).

4. Institute a chemical hygiene program. A mandatory chemical hygiene program designed to minimize exposures is needed; it should be a regular, continuing effort, not merely a standby or short-term activity (6,11). Its recommendations should be followed in academic teaching laboratories as well as by full-time laboratory workers (13).

5. Observe the PELs, TLVs. The Permissible Exposure Limits of OSHA and the Threshold Limit Values of the American Conference of Governmental Industrial Hygienists should not be exceeded (13).

B. Chemical Hygiene Responsibilities

Responsibility for chemical hygiene rests at all levels (6, 11, 21) including the:

1. Chief executive officer, who has ultimate responsibility for chemical hygiene within the institution and must, with other administrators, provide continuing support for institutional chemical hygiene (7, 11).

2. Supervisor of the department or other administrative unit, who is responsible for chemical hygiene in that unit (7).

3. Chemical hygiene officer(s), whose appointment is essential (7) and who must:
   (a) Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices (7);
   (b) Monitor procurement, use, and disposal of chemicals used in the lab (8);
   (c) See that appropriate audits are maintained (8);
   (d) Help project directors develop precautions and adequate facilities (10);
   (e) Know the current legal requirements concerning regulated substances (50); and
   (f) Seek ways to improve the chemical hygiene program (8, 11).

4. Laboratory supervisor, who has overall responsibility for chemical hygiene in the laboratory (21) including responsibility to:
   (a) Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided (21, 22);
   (b) Provide regular, formal chemical hygiene and housekeeping inspections including routine inspections of emergency equipment (21, 171);
   (c) Know the current legal requirements concerning regulated substances (50, 231);
   (d Determine the required levels of protective apparel and equipment (156, 160, 162); and
   (e) Ensure that facilities and training for use of any material being ordered are adequate (215).

5. Project director or director of other specific operation, who has primary responsibility for chemical hygiene procedures for that operation (7).

6. Laboratory worker, who is responsible for:
   (a) Planning and conducting each operation in accordance with the institutional chemical hygiene procedures (7, 21, 22, 230); and
   (b) Developing good personal chemical hygiene habits (22).

C. The Laboratory Facility

1. Design. The laboratory facility should have:

   (a) An appropriate general ventilation system (see C4 below) with air intakes and exhausts located so as to avoid intake of contaminated air (194);
   (b) Adequate, well-ventilated stockrooms/storerooms (218, 219).
   (c) Laboratory hoods and sinks (12, 162);
   (d) Other safety equipment including eyewash fountains and drench showers (162, 169); and
   (e) Arrangements for waste disposal (12, 240).

2. Maintenance. Chemical-hygiene-related equipment (hoods, incinerator, etc.) should undergo continual appraisal and be modified if inadequate (11, 12).

3. Usage. The work conducted (10) and its scale (12) must be appropriate to the physical facilities available and, especially, to the quality of ventilation (13).

4. Ventilation -
   (a) General laboratory ventilation. This system should: Provide a source of air for breathing and for input to local ventilation devices (199); it should not be relied on for protection from toxic substances released into the laboratory (198); ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day (194); direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building (194).
   (b) Hoods. A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals (199); each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use (200, 209). If this is not possible, work with substances of unknown toxicity should be avoided (13) or other types of local ventilation devices should be provided (199). See pp. 201-206 for a discussion of hood design, construction, and evaluation.
   (c) Other local ventilation devices. Ventilated storage cabinets, canopy hoods, snorkels, etc. should be provided as needed (199). Each canopy hood and snorkel should have a separate exhaust duct (207).
   (d) Special ventilation areas. Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before release into the regular exhaust system (208). Cold rooms and warm rooms should have provisions for rapid escape and for escape in the event of electrical failure (209).
   (e) Modifications. Any alteration of the ventilation system should be made only if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate (12, 193, 204).
   (f) Performance. Rate: 4-12 room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control (194).
   (g) Quality. General air flow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas (194, 195); airflow into and within the hood should not be excessively turbulent (200); hood face velocity should be adequate (typically 60-100 lfm) (200, 204). (h) Evaluation. Quality and quantity of ventilation should be evaluated on installation (202), regularly monitored (at least every 3 months) (6, 12, 14, 195), and reevaluated whenever a change in local ventilation devices is made (12, 195, 207). See pp 195-198 for methods of evaluation and for calculation of estimated airborne contaminant concentrations.

D. Components of the Chemical Hygiene Plan

1. Basic Rules and Procedures (Recommendations for these are given in section E, below)

2. Chemical Procurement, Distribution, and Storage

   (a) Procurement. Before a substance is received, information on proper handling, storage, and disposal should be known to those who will be involved (215, 216). No container should be accepted without an adequate identifying label (216). Preferably, all substances should be received in a central location (216).
   (b) Stockrooms/storerooms. Toxic substances should be segregated in a well-identified area with local exhaust ventilation (221). Chemicals which are highly toxic (227) or other chemicals whose containers have been opened should be in unbreakable secondary containers (219). Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity (218-19). Stockrooms/storerooms should not be used as preparation or repackaging areas, should be open during normal working hours, and should be controlled by one person (219).
   (c) Distribution. When chemicals are hand carried, the container should be placed in an outside container or bucket. Freight-only elevators should be used if possible (223).
   (d) Laboratory storage. Amounts permitted should be as small as practical. Storage on bench tops and in hoods is inadvisable. Exposure to heat or direct sunlight should be avoided. Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom (225-6, 229).

3. Environmental Monitoring

Regular instrumental monitoring of airborne concentrations is not usually justified or practical in laboratories but may be appropriate when testing or redesigning hoods or other ventilation devices (12) or when a highly toxic substance is stored or used regularly (e.g., 3 times/week) (13).

4. Housekeeping, Maintenance, and Inspections

   (a) Cleaning. Floors should be cleaned regularly (24).
   (b) Inspections. Formal housekeeping and chemical hygiene inspections should be held at least quarterly (6, 21) for units which have frequent personnel changes and semiannually for others; informal inspections should be continual (21).
   (c) Maintenance. Eye wash fountains should be inspected at intervals of not less than 3 months (6). Respirators for routine use should be inspected periodically by the laboratory supervisor (169). Other safety equipment should be inspected regularly. (e.g., every 3-6 months) (6, 24, 171). Procedures to prevent restarting of out-of-service equipment should be established (25).
   (d) Passageways. Stairways and hallways should not be used as storage areas (24). Access to exits, emergency equipment, and utility controls should never be blocked (24).

5. Medical Program

(a) Compliance with regulations. Regular medical surveillance should be established to the extent required by regulations (12).
(b) Routine surveillance. Anyone whose work involves regular and frequent handling of toxicologically significant quantities of a chemical should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable (11, 50).
(c) First aid. Personnel trained in first aid should be available during working hours and an emergency room with medical personnel should be nearby (173). See pp. 176-178 for description of some emergency first aid procedures.

6. Protective Apparel and Equipment

These should include for each laboratory: (a) Protective apparel compatible with the required degree of protection for substances being handled (158-161); (b) An easily accessible drench-type safety shower (162, 169); (c) An eyewash fountain (162) (d) A fire extinguisher (162-164); (e) Respiratory protection (164-9), fire alarm and telephone for emergency use (162) should be available nearby; and (f) Other items designated by the laboratory supervisor (156, 160).

7. Records

(a) Accident records should be written and retained (174).
(b) Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations (7).
(c) Inventory and usage records for high-risk substances should be kept as specified in sections E3e below.
(d) Medical records should be retained by the institution in accordance with the requirements of state and federal regulations (12).

8. Signs and Labels

Prominent signs and labels of the following types should be posted:
(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers (28);
(b) Identity labels, showing contents of containers (including waste receptacles) and associated hazards (27, 48);
(c) Location signs for safety showers, eyewash stations, other safety and first aid equipment, exits (27) and areas where food and beverage consumption and storage are permitted (24); and
(d) Warnings at areas or equipment where special or unusual hazards exist (27).

9. Spills and Accidents

(a) A written emergency plan should be established and communicated to all personnel; it should include procedures for ventilation failure (200), evacuation, medical care, reporting, and drills (172).
(b) There should be an alarm system to alert people in all parts of the facility including isolation areas such as cold rooms (172).
(c) A spill control policy should be developed and should include consideration of prevention, containment, cleanup, and reporting (175).

(d) All accidents or near accidents should be carefully analyzed with the results distributed to all who might benefit (8, 28).

10. Information and Training Program

(a) Aim: To assure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs (5, 15).
(b) Emergency and Personal Protection Training: Every laboratory worker should know the location and proper use of available protective apparel and equipment (154, 169). Some of the full-time personnel of the laboratory should be trained in the proper use of emergency equipment and procedures (6). Such training as well as first aid instruction should be available to (154) and encouraged for (176) everyone who might need it.
(c) Receiving and stockroom/storeroom personnel should know about hazards, handling equipment, protective apparel, and relevant regulations (217).
(d) Frequency of Training: The training and education program should be a regular, continuing activity - not simply an annual presentation (15).
(e) Literature/Consultation: Literature and consulting advice concerning chemical hygiene should be readily available to laboratory personnel, who should be encouraged to use these information resources (14).

11. Waste Disposal Program.

(a) Aim: To assure that minimal harm to people, other organisms, and the environment will result from the disposal of waste laboratory chemicals (5).
(b) Content (14, 232, 233, 240): The waste disposal program should specify how waste is to be collected, segregated, stored, and transported and include consideration of what materials can be incinerated. Transport from the institution must be in accordance with DOT regulations (244).
(c) Discarding Chemical Stocks: Unlabeled containers of chemicals and solutions should undergo prompt disposal; if partially used, they should not be opened (24, 27). Before a worker's employment in the laboratory ends, chemicals for which that person was responsible should be discarded or returned to storage (226).
(d) Frequency of Disposal: Waste should be removed from laboratories to a central waste storage area at least once per week and from the central waste storage area at regular intervals (14).
(e) Method of Disposal: Incineration in an environmentally acceptable manner is the most practical disposal method for combustible laboratory waste (14, 238, 241). Indiscriminate disposal by pouring waste chemicals down the drain (14, 231, 242) or adding them to mixed refuse for landfill burial is unacceptable (14). Hoods should not be used as a means of disposal for volatile chemicals (40, 200). Disposal by recycling (233, 243) or chemical decontamination (40, 230) should be used when possible.

E. Basic Rules and Procedures for Working with Chemicals

The Chemical Hygiene Plan should require that laboratory workers know and follow its rules and procedures. In addition to the procedures of the sub programs mentioned above, these should include the rules listed below.

1. General Rules

The following should be used for essentially all laboratory work with chemicals:

(a) Accidents and spills - Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention (33, 172). Ingestion: Encourage the victim to drink large amounts of water (178). Skin Contact: Promptly flush the affected area with water (33, 172, 178) and remove any contaminated clothing (172, 178). If symptoms persist after washing, seek medical attention (33). Clean-up. Promptly clean up spills, using appropriate protective apparel and equipment and proper disposal (24, 33). See pp. 233-237 for specific clean-up recommendations.

(b) Avoidance of "routine" exposure: Develop and encourage safe habits (23); avoid unnecessary exposure to chemicals by any route (23); Do not smell or taste chemicals (32). Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices (199). Inspect gloves (157) and test glove boxes (208) before use. Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres (209).

(c) Choice of chemicals: Use only those chemicals for which the quality of the available ventilation system is appropriate (13).

(d) Eating, smoking, etc.: Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present (22, 24, 32, 40); wash hands before conducting these activities (23, 24). Avoid storage, handling, or consumption of food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations (23, 24, 226).

(e) Equipment and glassware: Handle and store laboratory glassware with care to avoid damage; do not use damaged glassware (25). Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur (25). Use equipment only for its designed purpose (23, 26).

(f) Exiting: Wash areas of exposed skin well before leaving the laboratory (23).

(g) Horseplay: Avoid practical jokes or other behavior which might confuse, startle or distract another worker (23).

(h) Mouth suction: Do not use mouth suction for pipeting or starting a siphon (23, 32).

(I) Personal apparel: Confine long hair and loose clothing (23, 158). Wear shoes at all times in the laboratory but do not wear sandals, perforated shoes, or sneakers (158).

(j) Personal housekeeping: Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation or at the end of each day (24).

(k) Personal protection: Assure that appropriate eye protection (154-156) is worn by all persons, including visitors, where chemicals are stored or handled (22, 23, 33, 154). Wear appropriate gloves when the potential for contact with toxic materials exists (157); inspect the gloves before each use, wash them before removal, and replace them periodically (157). (A table of resistance to chemicals of common glove materials is given p. 159). Use appropriate (164-168) respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls (164-5), inspecting the respirator before use (169). Use any other protective and emergency apparel and equipment as appropriate (22, 157-162). Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken (155). Remove laboratory coats immediately on significant contamination (161).

(l) Planning: Seek information and advice about hazards (7), plan appropriate protective procedures, and plan positioning of equipment before beginning any new operation (22, 23).
(m) Unattended operations: Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water) to an unattended operation (27, 128).
(n) Use of hood: Use the hood for operations which might result in release of toxic chemical vapors or dust (198-9). As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less than 50 ppm (13). Confirm adequate hood performance before use; keep hood closed at all times except when adjustments within the hood are being made (200); keep materials stored in hoods to a minimum and do not allow them to block vents or air flow (200). Leave the hood "on" when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off" (200).
(o) Vigilance: Be alert to unsafe conditions and see that they are corrected when detected (22).
(p) Waste disposal: Assure that the plan for each laboratory operation includes plans and training for waste disposal (230). Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (22, 24). Do not discharge to the sewer concentrated acids or bases (231); highly toxic, malodorous, or lachrymatory substances (231); or any substances which might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow (242).
(q) Working alone: Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous (28).

2. Working with Allergens and Embryotoxins

(a) Allergens (examples: diazomethane, isocyanates, bichromates): Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity (35).
(b) Embryotoxins (34-5) (examples: organomercurials, lead compounds, formamide): If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact. Review each use of these materials with the research supervisor and review continuing uses annually or whenever a procedural change is made. Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container. Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

3. Work with Chemicals of Moderate Chronic or High Acute Toxicity

Examples: diisopropylfluorophosphate (41), hydrofluoric acid (43), hydrogen cyanide (45).
Supplemental rules to be followed in addition to those mentioned above (Procedure B of "Prudent Practices", pp. 39-41):
(a) Aim: To minimize exposure to these toxic substances by any route using all reasonable precautions (39).

(b) Applicability: These precautions are appropriate for substances with moderate chronic or high acute toxicity used in significant quantities (39).
(c) Location: Use and store these substances only in areas of restricted access with special warning signs (40, 229). Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) (40) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance (39); trap released vapors to revent their discharge with the hood exhaust (40).
(d) Personal protection: Always avoid skin contact by use of gloves and long sleeves (and other protective apparel as appropriate) (39). Always wash hands and arms immediately after working with these materials (40).
(e) Records: Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved (40, 229).
(f) Prevention of spills and accidents: Be prepared for accidents and spills (41). Assure that at least 2 people are present at all times if a compound in use is highly toxic or of unknown toxicity (39). Store breakable containers of these substances in chemically resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper (40). If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment (41).
(g) Waste: Thoroughly decontaminate or incinerate contaminated clothing or shoes (41). If possible, chemically decontaminate by chemical conversion (40). Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite) (40).

4. Work with Chemicals of High Chronic Toxicity

(Examples: dimethylmercury and nickel carbonyl (48), benzo-a-pyrene (51), N-nitrosodiethylamine (54), other human carcinogens or substances with high carcinogenic potency in animals (38).) Further supplemental rules to be followed, in addition to all these mentioned above, for work with substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance) (47). (Procedure A of "Prudent Practices" pp. 47-50).
(a) Access: Conduct all transfers and work with these substances in a "controlled area": a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances, for which all people with access are aware of the substances being used and necessary precautions (48).
(b) Approvals: Prepare a plan for use and disposal of these materials and obtain the approval of the laboratory supervisor (48).
(c) Non-contamination/Decontamination: Protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood (49). Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area (49, 50). Decontaminate the controlled area before normal work is resumed there (50).
(d) Exiting: On leaving a controlled area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck (49).
(e) Housekeeping: Use a wet mop or a vacuum cleaner equipped with a HEPA filter instead of dry sweeping if the toxic substance was a dry powder (50). (f) Medical surveillance: If using toxicologically significant quantities of such a substance on a

regular basis (e.g., 3 times per week), consult a qualified physician concerning desirability of regular medical surveillance (50).

(g) Records: Keep accurate records of the amounts of these substances stored (229) and used, the dates of use, and names of users (48).

(h) Signs and labels: Assure that the controlled area is conspicuously marked with warning and restricted access signs (49) and that all containers of these substances are appropriately labeled with identity and warning labels (48).

(I) Spills: Assure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available (233-4).

(j) Storage: Store containers of these chemicals only in a ventilated, limited access (48, 227, 229) area in appropriately labeled, unbreakable, chemically resistant, secondary containers (48, 229).

(k) Glove boxes: For a negative pressure glove box, ventilation rate must be at least 2 volume changes/hour and pressure at least 0.5 inches of water (48). For a positive pressure glove box, thoroughly check for leaks before each use (49). In either case, trap the exit gases or filter them through a HEPA filter and then release them into the hood (49).

(l) Waste: Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in a secondary container under the supervision of authorized personnel (49, 50, 233).

5. Animal Work with Chemicals of High Chronic Toxicity

(a) Access: For large scale studies, special facilities with restricted access are preferable (56).

(b) Administration of the toxic substance: When possible, administer the substance by injection or gavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed toward HEPA filters (56).
(c) Aerosol suppression: Devise procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces (e.g., use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood) (55, 56).
(d) Personal protection: When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed because of incomplete suppression of aerosols, other apparel and equipment (shoe and head coverings, respirator) (56).
(e) Waste disposal: Dispose of contaminated animal tissues and excreta by incineration if the available incinerator can convert the contaminant to non-toxic products (238); otherwise, package the waste appropriately for burial in an EPA-approved site (239).

F. Safety Recommendations

The above recommendations from "Prudent Practices" do not include those which are directed primarily toward prevention of physical injury rather than toxic exposure. However, failure of precautions against injury will often have the secondary effect of causing toxic exposures. Therefore, we list below page references for recommendations concerning some of the major categories of safety hazards which also have implications for chemical hygiene:

1. Corrosive agents: (35-6)
2. Electrically powered laboratory apparatus: (179-92)
3. Fires, explosions: (26, 57-74, 162-64, 174-5, 219-20, 226-7)
4. Low temperature procedures: (26, 88)
5. Pressurized and vacuum operations (including use of compressed gas cylinders): (27, 75-101)

G. Material Safety Data Sheets

Material safety data sheets are presented in "Prudent Practices" for the chemicals listed below. (Asterisks denote that comprehensive material safety data sheets are provided).

- Acetyl peroxide (105)
- Acrolein (106)
- Acrylonitrile

Ammonia (anhydrous)(91)

- Aniline (109)
- Benzene (110)
- Benzo[a]pyrene (112)
- Bis(chloromethyl) ether (113)

Boron trichloride (91)
Boron trifluoride (92)
Bromine (114)

- Tert-butyl hydroperoxide (148)
- Carbon disulfide (116)

Carbon monoxide (92)
- o Carbon tetrachloride (118)
- o Chlorine (119)

Chlorine trifluoride (94)
- o Chloroform (121)

Chloromethane (93)
- o Diethyl ether (122)

Diisopropyl fluorophosphate (41)
- o Dimethylformamide (123)
- o Dimethyl sulfate (125)
- o Dioxane (126)
- o Ethylene dibromide (128)
- o Fluorine (95)
- o Formaldehyde (130)
- o Hydrazine and salts (132)

Hydrofluoric acid (43)
Hydrogen bromide (98)
Hydrogen chloride (98)
- o Hydrogen cyanide (133)
- o Hydrogen sulfide (135)

Mercury and compounds (52)
- o Methanol (137)
- o Morpholine (138)
- o Nickel carbonyl (99)
- o Nitrobenzene (139)

Nitrogen dioxide (100)
N-nitrosodiethylamine (54)
- o Peracetic acid (141)
- o Phenol (142)
- o Phosgene (143)
- o Pyridine (144)
- o Sodium azide (145)
- o Sodium cyanide (147)

Sulfur dioxide (101)
- o Trichloroethylene (149)
- o Vinyl chloride (150)

1910.1450 Appendix B - References (Non-Mandatory)

The following references are provided to assist the employer in the development of a Chemical Hygiene Plan. The materials listed below are offered as non-mandatory guidance. References listed here do not imply specific endorsement of a book, opinion, technique, policy or a specific solution for a safety or health problem. Other references not listed here may better meet the needs of a specific laboratory.

(a) Materials for the Development of the Chemical Hygiene Plan:

1. American Chemical Society, Safety in Academic Chemistry Laboratories, 4th edition, 1985.

2. Fawcett, H.H. and W.S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd edition, Wiley-Interscience, New York, 1982.

3. Flury, Patricia A., Environmental Health and Safety in the Hospital Laboratory, Charles C. Thomas Publisher, Springfield IL, 1978.

4. Green, Michael E. and Turk, Amos, Safety in Working with Chemicals, Macmillan Publishing Co., NY, 1978.

5. Kaufman, James A., Laboratory Safety Guidelines, Dow Chemical Co., Box 1713, Midland, MI 48640, 1977.

6. National Institutes of Health, NIH Guidelines for the Laboratory use of Chemical Carcinogens, NIH Pub. No. 81-2385, GPO, Washington, DC 20402, 1981.

7. National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington, DC, 1983.

8. National Research Council, Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, Washington, DC, 1981.

9. Renfrew, Malcolm, Ed., Safety in the Chemical Laboratory, Vol. IV, J. Chem. Ed., American Chemical Society, Easlon, PA, 1981.

10. Steere, Norman V., Ed., Safety in the Chemical Laboratory, J. Chem. Ed. American Chemical Society, Easlon, PA, 18042, Vol. I, 1967, Vol. II, 1971, Vol. III, 1974.

11. Steere, Norman V., Handbook of Laboratory Safety, the Chemical Rubber Company Cleveland, OH, 1971.

12. Young, Jay A., Ed., Improving Safety in the Chemical Laboratory, John Wiley & Sons, Inc. New York, 1987.

(b) Hazardous Substances Information:

1. American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes, 6500 Glenway Avenue, Bldg. D-7, Cincinnati, OH 45211-4438.

2. Annual Report on Carcinogens, National Toxicology Program U.S. Department of Health and Human Services, Public Health Service, U.S. Government Printing Office, Washington, DC, (latest edition).

3. Best Company, Best Safety Directory, Vols. I and II, Oldwick, N.J., 1981.

4. Bretherick, L., Handbook of Reactive Chemical Hazards, 2nd edition, Butterworths, London, 1979.

5. Bretherick, L., Hazards in the Chemical Laboratory, 3rd edition, Royal Society of Chemistry, London, 1986.

6. Code of Federal Regulations, 29 CFR part 1910 subpart Z. U.S. Govt. Printing Office, Washington, DC 20402 (latest edition).

7. IARC Monographs on the Evaluation of the Carcinogenic Risk of chemicals to Man, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, New York 12210 (latest editions).

8. NIOSH/OSHA Pocket Guide to Chemical Hazards. NIOSH Pub. No. 85-114, U.S. Government Printing Office, Washington, DC, 1985 (or latest edition).

9. Occupational Health Guidelines, NIOSH/OSHA. NIOSH Pub. No. 81-123 U.S. Government Printing Office, Washington, DC, 1981.

10. Patty, F.A., Industrial Hygiene and Toxicology, John Wiley & Sons, Inc., New York, NY (Five Volumes).

11. Registry of Toxic Effects of Chemical Substances, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Revised Annually, for sale from Superintendent of documents US. Govt. Printing Office, Washington, DC 20402.

12. The Merck Index: An Encyclopedia of Chemicals and Drugs. Merck and Company Inc. Rahway, N.J., 1976 (or latest edition).

13. Sax, N.I. Dangerous Properties of Industrial Materials, 5th edition, Van Nostrand Reinhold, NY., 1979.

14. Sittig, Marshall, Handbook of Toxic and Hazardous Chemicals, Noyes Publications. Park Ridge, NJ, 1981.

(c) Information on Ventilation:

1. American Conference of Governmental Industrial Hygienists Industrial Ventilation (latest edition), 6500 Glenway Avenue, Bldg. D-7, Cincinnati, Ohio 45211-4438.

2. American National Standards Institute, Inc. American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems ANSI Z 9.2-1979 American National Standards Institute, N.Y. 1979.

3. Imad, A.P. and Watson, C.L. Ventilation Index: An Easy Way to Decide about Hazardous Liquids, Professional Safety pp 15-18, April 1980.

4. National Fire Protection Association, Fire Protection for Laboratories Using Chemicals NFPA-45, 1982.

Safety Standard for Laboratories in Health Related Institutions, NFPA, 56c, 1980.

Fire Protection Guide on Hazardous Materials, 7th edition, 1978.

National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

5. Scientific Apparatus Makers Association (SAMA), Standard for Laboratory Fume Hoods, SAMA LF7-1980, 1101 16th Street, NW., Washington, DC 20036.

(d) Information on Availability of Referenced Material:

1. American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.

2. American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.

[55 FR 3327, Jan. 31, 1990; 57 FR 29204, July 1, 1992; 61 FR 5507, Feb. 13, 1996]

§ **1910.1499 Source of Standards**

Section 1910.1000	41 CFR 50-204-50, except for Table Z-2, the source of which is American National Standards Institute Z37 series.

[40 FR 2307, May 28, 1975]

§ **1910.1500 Standards Organizations.**

Specific standards of the following organizations have been referred to in this subpart. Copies of the standards may be obtained from the issuing organization.

American Conference of governmental Industrial Hygienists
1014 Broadway
Cincinnati, Ohio 45202

American National Standards Institute
1430 Broadway
New York, New York 10018

[40 FR 23073, May 28, 1975, as amended at 43 FR 57603, Dec. 8, 1978]

OSHA Permissible Exposure Limit

A Permissible Exposure Limit (PEL) is a Time Weighted Average (TWA) concentration that must not be exceeded during any 8-hour work shift of a 40-hour work week. A Short Term Exposure Limit (STEL) is measured over a 15-minute period. A "ceiling" concentration must not be exceeded during any part of the workday; if instantaneous monitoring is not feasible, the ceiling must be assessed as a 15-minute TWA exposure. The "skin" designation indicates the potential for dermal absorption; skin exposure should be prevented as necessary through the use of good work practices and gloves, goggles, and other appropriate equipment.

Chemical Name	**PEL (ppm)**	**PEL (mg/m^3)**	**Comment**
Acetaldehyde	200	360	
Acetic acid	10	25	
Acetone	1000	2400	
Acetonitrile	40	70	
STEL	60	105	
Acrolein	0.1	0.25	
STEL	0.3	0.69	
Acrylamide		0.3	skin
Acrylonitrile	2		
Ammonia (anhydrous)	35	27	
Ammonium hydroxide	35	27	
Aniline	5	19	skin
Arsine	0.05	0.2	
Benzene	1	3.2	
Boron trifluoride	1	3	ceiling
Bromine	0.1		
Carbon disulfide	4	12	
STEL	12	36	skin
Carbon monoxide	50	55	
Carbon tetrachloride	2	13	
Chlorine	1	3	
Chloroform	50	240	ceiling
Chromium trioxide		0.1	ceiling
Diazomethane	0.2	0.4	
Diborane	0.1		
Dichloromethane	500		
Diethyl ether	400		
Dimethyl sulfate	1	5	skin
Dimethylformamide	10	30	skin

Chemical Name	PEL (ppm)	PEL (mg/m^3)	Comment
Dioxane	100	360	skin
Ethanol	1000	1900	
Ethyl acetate	400	1400	
Ethylene dibromide	20	150	
Ethylene oxide	1	2	
Fluorides (inorganic)		2.5	
Fluorine	0.1	0.2	
Formaldehyde	1	1.5	
STEL	2	2.5	
Hexane	500	1800	
Hydrazine	1	1.3	skin
Hydrobromic acid	3	10	
Hydrochloric acid	5	7	ceiling
Hydrogen cyanide	10	11	skin
Hydrogen fluoride	3		
Hydrofluoric acid	3		
Hydrogen peroxide	1	1.4	
Hydrogen sulfide	20	28	ceiling
Iodine	0.1	1	ceiling
Lead		0.05	
Mercury		0.1	ceiling
Methanol	200	260	
Methyl ethyl ketone	200	590	
Methyl iodide	5	28	skin
Nickel carbonyl	0.001	0.007	
Nitric acid	2 / 5		
Nitrogen dioxide			5 / 9 - ceiling
Osmium tetroxide	0.0002	0.002	
Ozone	0.1	0.2	
Phenol	5	19	skin
Phosgene	0.1	0.4	
Phosphorus		0.1	
Potassium hydroxide		2	
Pyridine	5	15	
Silver		0.01	
Sodium hydroxide		2	
Sulfur dioxide	5	13	
Sulfuric acid		1	
Tetrahydrofuran	200	590	

Chemical Name	PEL (ppm)	PEL (mg/m^3)	Comment
Toluene	200	750	
STEL	150	560	
Toluene diisocyanate	0.02	0.14	ceiling
Trimethyltin chloride		0.1	mg of tin

Examples of Incompatible Chemicals

Substances in the left hand column should be stored and handled so that they cannot accidentally come into contact with corresponding substances in the right hand column under uncontrolled conditions.

Chemical	Is Incompatible With
acetic acid	chromic acid, nitric acid, perchloric acid, peroxides, permanganates
acetic anhydride	Hydroxyl-containing compounds such as ethylene glycol and perchloric acid
acetylene	chlorine, bromine, copper, fluorine, silver, mercury
acetone	concentrated nitric and sulfuric acid mixtures
alkali and alkaline earth metals	water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
ammonia (anhydrous)	mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
ammonium nitrate	acids, powdered metals, flammable liquids, chlorates, nitrates, sulfur, finely divided organic or combustible materials
aniline	nitric acid, hydrogen peroxide
arsenical materials	any reducing agent
azides	acids
bromine	see chlorine
calcium oxide	water
carbon (activated)	calcium hypochlorite, all oxidizing agents
carbon tetrachloride	sodium
chlorates	ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
chromic acid and chromium trioxide	acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
chlorine	ammonia, acetylene, butadiene, butane, methane, propane or other petroleum gases, hydrogen, sodium carbide, benzene, finely divided metals, turpentine
chlorine dioxide	ammonia, methane, phosphine, hydrogen sulfide
copper	acetylene, hydrogen peroxide
cumene hydroperoxide	acids (organic and inorganic)
cyanides	acids

Chemical	Is Incompatible With
flammable liquids	ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
fluorine	everything
hydrazine	hydrogen peroxide, nitric acid, any other oxidant
hydrocarbons (e.g., propane, butane, benzene)	fluorine, chlorine, bromine, chromic acid, sodium peroxide
hydrocyanic acid	nitric acid, alkali
hydrofluoric acid (aqueous or anhydrous)	ammonia (aqueous or anhydrous)
hydrogen peroxide	copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, combustible materials
hydrogen sulfide	fuming nitric acid, oxidizing gases
hypochlorites	acids, activated carbon
iodine	acetylene, ammonia (aqueous or anhydrous), hydrogen
mercury	acetylene, fulminic acid, ammonia
nitrates	sulfuric acid
nitric acid (concentrated)	acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, copper, brass, any heavy metals
nitrites	acids
nitroparaffins	inorganic bases, amines
oxalic acid	silver, mercury
oxygen	oils, grease, hydrogen, flammable liquids, solids, or gases
perchloric acid	acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils
peroxides, organic	acids (organic or mineral), avoid friction, store cold
phosphorus (white)	air, oxygen, alkalis, reducing agents
phosphorus pentoxide	alcohols, strong bases, water
potassium	carbon tetrachloride, carbon dioxide, water
potassium chlorate	sulfuric and other acids
potassium perchlorate (also see chlorates)	sulfuric and other acids
potassium permanganate	glycerol, ethylene glycol, benzaldehyde, sulfuric acid
selenides	reducing agents

Chemical	Is Incompatible With
silver and silver salts	acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
sodium	carbon tetrachloride, carbon dioxide, water
sodium nitrite	ammonium nitrate and other ammonium salts
sodium peroxide	ethanol and methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
sulfides	acids
sulfuric acid	potassium chlorate, potassium perchlorate, potassium permanganate (and similar compounds of light metals such as sodium, lithium)
tellurides	reducing agents

Acutely Hazardous Waste

1-Acetyl-2-thiourea
Acrolein
Aldicarb
Aldrin
Allyl alcohol
Aluminum phosphide
5-(Aminomethyl)-3-isoxazolol
4-Aminopyridine
Ammonium picrate
Ammonium vanadate
Arsenic acid
Arsenous oxide
Arsenic oxide
Aziridine
Barium cyanide
Benzyl chloride
Beryllium
Bis(chloromethyl)ether
1-Bromo-2-propanone
Brucine
Calcium cyanide
Carbon disulfide
Chloroacetaldehyde
p-Chloroaniline
(2-Chlorophenyl)thiourea
3-Chloropropionitrile
Cuprous cyanide
Cupric cyanide
Cyanides (water-soluble salts)
Cyanogen
Cyanogen chloride
2-Cyclohexyl-4,6-dinitrophenol
Dichlorophenylarsine
Dieldrin
Diethylarsine
Diethyl-*p*-nitrophenyl phosphate
O,O-Diethyl O-pyrazinyl phosphorothioate
Diisopropylfluorophosphate
Dimethonate
α,α -Dimethylphenethylamine
4,6-Dinitro-*o*-cresol (and salts)

Acutely Hazardous Waste (Con't.)

2,4-Dinitrophenol
Disulfoton
Dithiobiuret
Endosulfan
Endothall
Endrin (and metabolites)
Epinephrine
Ethanimidothioic acid, *N*- [[(methylamino)carbonyl]oxy]-, methyl ester
Famphur
Fluorine
Fluoroacetamide
Heptachlor
Hydrogen cyanide (pure or in solution)
2-Hydroxy-2-methylpropanenitrile
Isodrin
Mercury fulminate

2-Methylaziridine
Methyl hydrazine
Methyl isocyanate
Methyl parathion
2-(1-Methylpropyl)-4,6-dinitrophenol
α -Naphthylthiourea
Nickel carbonyl
Nickel cyanide
Nicotine (and salts)
Nitric oxide
p-Nitroaniline
Nitrogen dioxide
Nitroglycerine
N-Nitrosodimethylamine
N-Nitrosomethylvinylamine
Octamethylpyrophosphoramide
Osmium tetroxide
Parathion
Phenylmercury acetate
Phenylthiourea
Phorate
Phosgene
Phosphine
Potassium cyanide
Potassium silver cyanide

Acutely Hazardous Waste (Con't.)

Propanenitrile
Propargyl alcohol
Selenourea
Silver cyanide
Sodium azide
Sodium cyanide
Sodium fluoroacetate
Strychnine (and salts)
Tetraethyl lead
Tetraethyl pyrophosphate
Tetranitromethane
Tetraphosphoric acid, hexaethyl ester
Thallic oxide
Thallium (I) selenite
Thallium (I) sulfate
Thiodiphosphoric acid, tetraethyl ester
Thiofanox
Thiophenol
Thiosemicarbazide
Toxaphene
Trichloromethanethiol
Vanadium pentoxide
Warfarin (and salts, when either are present at concentrations greater than 0.3%)
Zinc cyanide
Zinc phosphide (when present at concentrations greater than 10%)

Gloves

The following gloves are stocked at the Research Storeroom in the basement of Welch Hall (WEL). Next to each glove listed is a short description of its use.

Latex "surgeons" or "exam" gloves - a general use lab glove, provides *minimal chemical resistance*.

Nytek - a white nitrile latex glove that is *solvent resistant*. It provides chemical resistance *as well as tactile sensitivity*.

Butyl - provides protection against *ketones, esters, and other hydrocarbon solvents*.

N-DEX nitrile - *chemical resistant primarily for acids, bases, aldehydes, and alcohols* and provides better puncture and abrasion resistance than PVC/vinyl or polyethylene gloves.

Zetex - silica fabric withstands *temperatures from -100˚F to 1100˚F (-148˚C to 2012˚C)*. These gloves resist *abrasion, most acids (except hydrofluoric acid), alkalis, and solvents.*

Neoprene/Latex - blue neoprene over yellow latex offers *superior chemical resistance in heavy duty applications*. Resistant to *acids, detergents, salts, caustics, animal fats, and alcohols*. Also offers an excellent grip on wet or dry surfaces.

The *gloves listed above show poor resistance* to the following chemicals :

benzene	carbon disulfide
carbon tetrachloride	chloroform
methylene chloride	*n*-pentane
toluene	1,1,1-trichloroethane
trichloroethylene	xylene

For these chemicals, a glove material such as *VITON shows excellent resistance*.

Peroxide Forming Chemicals

The following classes of chemicals tend to form peroxides upon aging.

Class I - Unsaturated materials, especially those of low molecular weight, may polymerize violently and hazardously due to peroxide initiation.

- acrylic acid
- acrylonitrile
- 1,3-butadiene
- 2-chloro-1,3-butadiene (chloroprene)
- chlorotrifluoroethylene
- 1,1-dichloroethene
- methyl methacrylate
- styrene
- tetrafluoroethylene
- vinyl acetate
- vinyl acetylene
- vinyl chloride
- vinyl pyridine
- vinylidene chloride

Class II - The following chemicals are a peroxide hazard upon concentration (distillation/evaporation). A test for peroxides should be performed if concentration is intended or suspected.

- acetal
- cyclohexene
- cyclooctene
- cyclopentene
- diacetylene
- dicyclopentadiene
- diethylene glycol dimethyl ether (diglyme)
- diethyl ether
- dioxane (p-dioxane)
- ethylene glycol dimethyl ether (glyme)
- furan
- isopropyl benzene
- methylacetylene
- methylcyclopentane
- methylisobutyl ketone
- tetrahydrofuran
- tetrahydronaphthalene
- vinyl ethers

Class III - Peroxides derived from the following compounds may explode without concentration.

- divinyl ether
- divinyl acetylene
- diisopropyl ether
- 1,1-dichloroethene
- potassium metal
- potassium amide
- sodium amide

Potentially Explosive Chemicals

The following is a partial list of chemical compounds and mixtures that are known to have explosive properties:

Alkali metal dinitrophenolates (dry or containing less than 15 percent water, by mass)

Ammonium nitrate-fuel oil mixture

Ammonium nitrate mixtures (containing more than 0.2 percent combustible substances)

Ammonium perchlorate

Ammonium picrate (dry or containing less than 10 percent water, by mass)

Azobisisobutyronitrile (AIBN)

Barium azide (dry or containing less than 50 percent water, by mass)

Barium styphnate

Cyclotetramethylenetetranitramine

Cyclotrimethylenetrinitramine

Deflagrating metal salts of aromatic nitro derivatives

2-Diazo-1-naphthol-4-sulfonyl chloride

1-Diazo-2-naphthol-4-sulfonyl chloride

Diazodinitrophenol (containing less than 40 percent water or a mixture of alcohol and water, by mass)

Diethylene glycol dinitrate

Dinitroglycoluril (Dingu)

Dinitrophenol (dry or containing less than 15 percent water, by mass)

Dinitroresorcinol (dry or containing less than 15 percent water, by mass)

N,N'-Dinitroso-N,N'-dimethylterephthalamide

N,N'-Dinitrosopentamethylenetetraamine

Dinitrosobenzene

Dipicryl sulfide (dry or containing less than 10 percent water, by mass)

Guanyl nitrosaminoguanylidene hydrazine (containing less than 30 percent water, by mass)

Guanyl nitrosaminoguanyltetrazene (containing less than 30 percent water or a mixture of alcohol and water, by mass)

Hexanitrodiphenylamine (Dipicrylamine; Hexyl)

Hexanitrostilbene

Hexatonal

Hexolite (dry or containing less than 15 percent water, by mass)

Lead azide (containing less than 20 percent water or a mixture of alcohol and water, by mass)

Lead mononitroresorcinate

Potentially Explosive Chemicals (Con't.)

Lead styphnate (lead trinitroresorcinate) (containing less than 20 percent water or a mixture of alcohol and water, by mass)

Mannitol hexanitrate (Nitromannite) (containing less than 40 percent water or mixture of alcohol and water, by mass)

5-Mercaptotetrazol-1-acetic acid

Mercury fulminate (containing less than 20 percent water or mixture of alcohol and water, by mass)

Nitrourea

5-Nitrobenzotriazole

Nitrocellulose (dry or containing less than 25 percent water or alcohol, by mass or plasticized with less than 18 percent plasticizing substance, by mass)

Nitroglycerin (containing less than 40 percent of a non-volatile water insoluble desensitizer, by mass or containing less than 90 percent alcohol, by mass)

Nitroguanidine (Picrite) (dry or containing less than 20 percent water, by mass)

Nitrosoguanidine

Nitrostarch (dry or containing less than 20 percent water, by mass)

Nitrotriazolone (NTO)

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

Pentaerythritol tetranitrate (pentaerythrite tetranitrate, PETN) (containing less than 25 percent water, by mass or containing less than 7 percent wax, by mass or containing less than 15 percent of a suitable desensitizer, by mass)

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

Potassium salts of aromatic nitro-derivatives, explosive.

RDX and HMX mixtures (containing less than 15 percent water, by mass or containing less than 10 percent of a suitable desensitizer, by mass)

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

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

Sodium salts of aromatic nitro-derivatives

Tetranitroaniline

Tetrazol-1-acetic acid

Trinitro-m-cresol

Trinitroaniline (picramide)

Trinitroanisole

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

Potentially Explosive Chemicals (Con't.)

Trinitrobenzenesulfonic acid

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

Trinitrochlorobenzene (picryl chloride)

Trinitrofluorenone

Trinitronaphthalene

Trinitrophenetole

Trinitrophenol (picric acid) (dry or containing less than 30 percent water, by mass)

Trinitrophenylmethylnitramine (tetryl)

Trinitroresorcinol (styphnic acid) (dry or containing less than 20 percent water, or mixture of alcohol and water, by mass)

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

Tritonal

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

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

GAS CYLINDER POLICY

The UT Austin Gas Cylinder policy, which went into effect in May 1993, requires that all gas cylinders purchased for use on campus must be returnable to the vendor. The only exception to this policy is for a compelling research reason. The original policy indicated such exceptions would require prior approval and that a $1,000 deposit would be required to cover potential disposal costs. The specific procedures to be followed to request permission to purchase a research gas in a non-returnable gas cylinder are outlined below.

The Principal Investigator (PI) should prepare a request for an exception and include the reason why a non-returnable gas cylinder purchase is essential. This request must contain a Letter of Credit commitment that specifically states the requesting PI will be responsible for the proper disposal of the non-returnable cylinder and agrees to pay a $1,000 disposal fee if The University is required to dispose of the cylinder. This request should be submitted to the department chair and the dean for review and approval. The request should then be forwarded to the Provost for final action. Please note: identification of a specific account or funding source by the PI for the possible $1,000 disposal expenditure is not required but approval by the department and the college constitutes a commitment by them that, if necessary, department or college funds are available to cover any required disposal costs if the PI is unable to cover these costs.

A copy of the approval request will be returned to the PI and a copy will be forwarded to the Office of Environmental Health and Safety (OEHS). The PI should attach a copy of the approved request to the purchase order used to obtain the desired gas.

Final disposal of the non-returnable gas cylinder should be completed no later than three years after purchase unless written approval for an extension is obtained from the Provost upon recommendation of the chair and dean. Evidence of the proper disposal of the cylinder must be provided to OEHS. If the cylinder is disposed of through normal channels (e.g. the OEHS Hazardous Waste Program) at no extra cost to The University, the $1,000 Letter of Credit commitment will be canceled. The cylinder will be acceptable for normal waste disposal if the valve has been removed from the cylinder and the cylinder has been cleaned. Similarly, if the cylinder has been returned to the manufacturer or distributor, and this is verified in the form of a receipt or a bill of lading, the Letter of Credit commitment will be canceled. If however, The University must dispose of the cylinder outside of normal procedures because of the cylinder's condition, e.g. damaged or corroded valve, the disposal fee of $1,000 will be assessed to the PI and it is the responsibility of the PI to provide an appropriate account for this charge at that time.

If there are questions about this policy, please contact Marye Anne Fox, Vice President for Research.

The University of Texas at Austin
Office of Environmental Health and Safety Office

Hazard Communication Program

1995

INTRODUCTION: TEXAS HAZARD COMMUNICATION ACT

A. BACKGROUND

1. The initial Hazard Communication Act in the State of Texas was passed by the 69th Legislature and became law effective January 1, 1986. The revised Act, including laws titled chapter 502 ("Hazard Communication Act") and chapter 506 ("Public Employer Community Right-to-Know Act"), was passed by the 73rd Legislature and became law effective September 1, 1993.

2. The purpose of this University “Written Plan” is (1) to identify the major requirements of the Texas Hazard Communication Act (THCA) and (2) to define The University’s approach or “plan” for complying with this Texas Law.

3. The format of this written plan is first to cite (in *italicized* print) the specific section and requirements. Following this will be an explanation as to the method The University will take in compliance. Only those sections that are pertinent to this written plan are included. Excluded are sections 502.010 through 502.016.

4. Copies of the “Texas Hazard Communication Act - Revised 1993” are available on request at the Office of Environmental Health and Safety (OEHS), Service Building 202, telephone number 471-3511 (mail code C2600).

B. APPLICABILITY OF THCA 502

1. This chapter applies only to employers who are not required to comply with 29 CFR 1910.1200 (OSHA Hazard Communication Act). As a public institution, The University of Texas at Austin does not come under the Occupational Safety and Health Act of 1970 (OSHA) unless contractual agreement for compliance with federal standards has been entered into on applications for federal grant funding.

2. Chemical manufacturers, importers, and distributors - although covered by the federal OSHA law - shall provide Material Safety Data Sheets (MSDSs) as required by Section 502.006. Penalties provided by Sections 502.014, 502.015, and 502.016 may be assessed against chemical manufacturers, importers, and distributors for failure to provide MSDSs.

3. This chapter, except Section 502.009 ("Employee Education Program"), does not apply to a hazardous chemical in a sealed and labeled package that is received and subsequently sold or transferred in that package if:

(a) the seal and label remain intact while the chemical is in the workplace; and

(b) the chemical does not remain in the workplace longer than five working days.

4. This chapter does not require labeling of the following chemicals:

(a) pesticides;

(b) any food, food additive, color additive, drug, cosmetic, medical, or veterinary device;

(c) any distilled spirits that are beverage alcohol, wine, or malt beverages intended for non industrial use;

(d) any consumer product or hazardous substance, when subject to a consumer product safety standard or labeling requirement of those Acts or regulations issued under those Acts by the Consumer Product Safety Commission;

5. This chapter does not require labeling of the following chemicals:

(a) pesticides;

(b) any food, food additive, color additive, drug, cosmetic, medical, or veterinary device;

(c) any distilled spirits that are beverage alcohol, wine, or malt beverages intended for non industrial use;

(d) any consumer product or hazardous substance, when subject to a consumer product safety standard or labeling requirement of those Acts or regulations issued under those Acts by the Consumer Product Safety Commission;

6. This chapter does not apply to:

(a) any hazardous waste, as that term is defined by the Federal Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. Section 6901 et seq.) when subject to regulations issued under that Act by the Environmental Protection Agency;

(b) a chemical in a laboratory under the direct supervision or guidance of a technically qualified individual if:

(i) labels on incoming containers are not removed or defaced;

(ii) the employer complies with section 502.006 ("MSDS") and 502.009 ("Employee Education Program") with respect to laboratory employees; and

(iii) the laboratory is not used primarily to produce hazardous chemicals in bulk for commercial purposes;

(c) tobacco or tobacco products;

(d) wood or wood products;

(e) articles;

(f) food, drugs, cosmetics, or alcoholic beverages in a retail food sale establishment that are packaged for sale to consumers;

(g) food, drugs, or cosmetics intended for personal consumption by an employee while in the workplace;

(h) any consumer product or hazardous substance, as those terms are defined in the Consumer Product Safety Act (15 U.S.C. Section 2051 et seq.) and Federal

Hazardous Substances Act (15 U.S.C. Section 1261 et seq.), respectively, if the employer can demonstrate it is used in the workplace in the same manner as normal consumer use and if the use results in a duration and frequency of exposure that is not greater than exposures experienced by consumers;

(i) any drug, as that term is defined in the Federal Food, Drug, and Cosmetic Act (21 U.S.C. Section 301 et seq.);

(j) radioactive waste.

PART I: DEFINITIONS (As Listed in Section 502.004 of the Act)

1. "Article" means a manufactured item.

2. "Board" means the Texas Board of Health.

3. "Chemical manufacturer" means an employer in Standard Industrial Classification (SIC) Codes 20-39 with a workplace where chemicals are produced for use or distribution.

4. "Chemical name" means:

   (a) the scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC) or the Chemical Abstracts Service (CAS) rules of nomenclature; or

   (b) a name that clearly identifies the chemical for the purpose of conducting a hazard evaluation.

5. "Common name" means a designation of identification, such as a code name, code number, trade name, brand name, or generic name, used to identify a chemical other than by its chemical name.

6. "Department" means the Texas Department of Health.

7. "Designated representative" means the individual or organization to whom an employee gives written authorization to exercise the employee's rights under this chapter, except that a recognized or certified bargaining agent is a designated representative regardless of written employee authorization.

8. "Director" means the director of the Texas Department of Health.

9. "Distributor" means a business in Standard Industrial Classification Major Industry Group 516 or 517 that supplies hazardous chemicals to an employer who must comply with this Act.

10. "Employee" means a person who may be or may have been exposed to hazardous chemicals in the person's workplace under normal operating conditions or foreseeable emergencies, and includes a person working for this state, a person working for a political subdivision of this state, or a member of a volunteer emergency service organization or, if the applicable OSHA standard or MSHA standard is not in effect, a person working for a private employer. Workers such as office workers or accountants who encounter

hazardous chemicals only in nonroutine, isolated instances are not employees for the purposes of this chapter.

NOTE: In addition to the final sentence in the foregoing paragraph, the July 21, 1993 ruling of the Texas Attorney General, Opinion No. DM-239, in regard to "students" is deemed of particular importance in both interpreting and implementing the Texas Hazard Communication Act:

> "Students are not 'employees' for the purpose of the Texas Hazard Communication Act, Texas Health and Safety Code sections 502.001-.016. Therefore, the Act is not applicable to students in their capacity as students, except for the requirements of section 502.004 (e) (5) (B) which requires that material safety data sheets must be maintained by the laboratory and made accessible to students."

11. "Employer" means a person engaged in private business who is regulated by the federal Occupational Safety and Health Act of 1970 (Pub. L. No. 91-596), or the state or a political subdivision of the state, including a state, county, or a municipal agency, a public school, **a college or a university**, a river authority or publicly owned utility, a volunteer emergency service organization, and other similar employers. The term does not include any person to whom the federal Occupational Safety and Health Act of 1970 (Pub. L. No. 91-596) is applicable if that employer is covered by the OSHA standard.

12. "Expose" or "Exposure" means that an employee is subjected to a hazardous chemical in the course of employment through any route of entry, including inhalation, ingestion, skin contact, or absorption. The term includes potential, possible, or accidental exposure under normal conditions of use or in a reasonably foreseeable emergency.

13. "Hazardous chemical" or "chemical" means an element, compound, or mixture of elements or compounds that is a physical hazard or health hazard as defined by the OSHA standard in 29 CFR Section 1910.1200 (c), or a hazardous substance as defined in the OSHA standard in 29 CFR Section 1910.1200 (d) (3), or by OSHA's written interpretations. A hazard determination may be made by employers who choose not to rely on the evaluations made by their suppliers if there are relevant qualitative or quantitative differences. A hazard determination shall involve the best professional judgment.

14. "Health hazard" has the meaning given that term by the OSHA standard (29 CFR 1910.1200 (c)).

15. "Identity" means a chemical or common name, or alphabetical or numerical identification, that is indicated on the material safety data sheet (MSDS) for the chemical. The identity used must permit cross references to be made among the workplace chemical list, the label, and the MSDS.

16. "Label" means any written, printed, or graphic material displayed on or affixed to a container of hazardous chemicals.

17. "Material Safety Data Sheet" ("MSDS") means a document containing chemical hazard and safe handling information that is prepared in accordance with the requirements of the OSHA standard for that document.

18. "MSHA Standard" means the Hazard Communication Standard issued by the Mining Safety and Health Administration.

19. "OSHA Standard" means the Hazard Communication Standard issued by the Occupational Safety and Health Administration and codified as 29 CFR Section 1910.1200.

20. "Physical hazard" means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive), or water-reactive in terms defined in the OSHA standard.

21. "Temporary workplace" means a stationary workplace that is staffed less than 20 hours a week. A temporary workplace may be considered to be a work area of the headquarters workplace from which employees are routinely dispatched. Temporary workplaces may include pumping stations, emergency response sites, and similar workplaces.

22. "Work area" means a room, defined space, utility structure, or an emergency response site in a workplace where hazardous chemicals are present, produced, or used and where employees are present.

23. "Workplace" means an establishment, job site, or project, at one geographical location containing one or more work areas with or without buildings, that is staffed 20 or more hours a week.

24. "Workplace chemical list" means a list of hazardous chemicals developed under section 502.005 (a).

PART II: WORKPLACE CHEMICAL LIST

Sec. 502.005. (THCA)

(a) For the purpose of worker right-to-know, an employer shall compile and maintain a workplace chemical list that contains the following information for each hazardous chemical normally present in the workplace or temporary workplace in excess of 55 gallons or 500 pounds or in excess of an amount that the board determines by rule for certain highly toxic or dangerous chemicals:

(1) the identity used on the MSDS and container label; and

(2) the work area in which the hazardous chemical is normally present.

(b) The employer shall update the workplace chemical list as necessary but at least by December 31 of each year. Each workplace chemical list shall be dated and signed by the person responsible for compiling the information.

(c) The workplace chemical list may be prepared for the workplace as a whole or for each work area or temporary workplace and must be readily available to employees and their representatives. All employees shall be made aware of the workplace chemical list before working with or in a work area containing hazardous chemicals.

(d) An employer shall maintain a workplace chemical list for at least 30 years. The employer shall send complete records to the director if the employer ceases to operate.

A. CHEMICAL LISTS:

Each University workplace or temporary workplace (The University's definition of workplace is a building) shall compile lists of hazardous chemicals present within these locations in accordance with the foregoing Section 502.005 and shall forward these lists to the Office of Environmental Health and Safety (Service Building 202, 62600) by January 31st of each year. It is the responsibility of the supervisor to make their employees aware of the workplace chemical list before working with or in a work area containing hazardous chemicals.

B. CHEMICAL LIST RECORDS:

The Office of Environmental Health and Safety shall maintain chemical lists for a period of at least 30 years.

PART III: MATERIAL SAFETY DATA SHEETS ("MSDS")

SEC. 502. 006. (THCA)

(a) A chemical manufacturer or distributor shall provide appropriate material safety data sheets to employers who acquire hazardous chemicals in this state with each initial shipment and with the first shipment after a MSDS is updated. The MSDSs must conform to the most current requirements of the OSHA standard.

(b) An employer shall maintain a legible copy of current MSDS for each hazardous chemical purchased. If the employer does not have a current MSDS for a hazardous chemical when the chemical is received at the workplace, the employer shall request a MSDS in writing from the manufacturer or distributor in a timely manner or shall otherwise obtain a current MSDS. The manufacturer or distributor shall respond with an appropriate MSDS in a timely manner.

(c) Material safety data sheets shall be readily available, on request, for review by employees or designated representatives at each workplace.

(d) A copy of a MSDS maintained by an employer under this section shall be provided to the director on request.

A. MATERIAL SAFETY DATA SHEETS - GENERAL PROCEDURES:

University purchase orders or telephone requests for hazardous chemicals shall stipulate that the most current Material Safety Data Sheets available for these products must be provided with the shipment or mailed to the purchaser. Upon receipt of the order at Central Receiving (main campus) or at a satellite location, the MSDS shall be sent to the OEHS. If a workplace (including laboratories) requires MSDSs for their area, OEHS should be contacted. These MSDSs should then be maintained in an organized manner within the work area and / or workplace, should be utilized in the mandated training of employees and, on request, shall be made available to any employee who works with or

may be exposed to the hazardous chemical or material. A Material Safety Data Sheet must be made available for review on request by Texas Department of Health representatives during their inspections of campus operations.

B. MATERIAL SAFETY DATA SHEETS - ALTERNATE SOURCES:

While the vendor is considered to be the primary source or supplier of Material Safety Data Sheets, the following are alternatives available within the University for obtaining a MSDS:

1. Sigma - Aldrich chemicals are available via the administrative mainframe *UTCAT (see Appendix A).

2. The Office of Environmental Health and Safety maintains a file of thousands of MSDS which may be reviewed for reproduction at Service Building 202.

3. Where a copy of a MSDS is not otherwise available, contact the Office of Environmental Health and Safety. OEHS will either contact the manufacturer or use other means of obtaining the data sheet.

PART IV: LABELS

Sec. 502. 007. (THCA)

(a) A label on an existing container of a hazardous chemical may not be removed or defaced unless it is illegible, inaccurate, or does not conform to the OSHA standard or other applicable labeling requirement. Primary containers must be relabeled with at least the identity appearing on the MSDS, the pertinent physical and health hazards, including the organs that would be affected, and the manufacturer's name and address. Except as provided by Subsection (b), secondary containers must be relabeled with at least the identity appearing on the MSDS and appropriate hazard warnings.

(b) An employee may not be required to work with a hazardous chemical from an unlabeled container except for a portable container intended for the immediate use of the employee who performs the transfer.

A. LABELS - GENERAL PROCEDURES:

1. The Supervisor of each University work area **(which includes laboratories)** where containers of hazardous chemicals are present is responsible for assuring that the manufacturer / supplier label is not removed or defaced unless it is illegible, inaccurate, or does not conform to the OSHA standard or other applicable labeling requirement.

2. Secondary containers must be labeled with at least the name of the chemical/compound (as it appears on the MSDS) and the hazard warnings. Exception: an employee who transfers the contents from a primary container into a secondary container for immediate use is not required to label the secondary container.

B. LABELS - PRIMARY CONTAINERS:

Primary containers of hazardous chemicals that might require relabeling must be relabeled with, at minimum, the name appearing on the MSDS, the pertinent physical and health hazards, including the organs that would be affected, and the manufacturer's name and address.

C. LABELS - SECONDARY CONTAINERS:

Secondary containers must be labeled with at least the name of the hazardous chemical appearing on the MSDS and the appropriate hazard warnings. An example of an acceptable Secondary container label:

HEXANE

Physical	CAS NO. 110-54-3
Hazard:	FLAMMABLE
Health	Irritant - Eyes, Nose, Respiratory tract
Hazard:	May Cause: cough, mild, depression, cardiat arrhythmia, lightheadedness, nausea, headache, dermatitis, pulmonary edema, numbness.

Consult Material Safety Data Sheet Before Using

PART V: OUTREACH PROGRAM

Sec. 502. 008. (THCA)

(a) The director shall develop an outreach program that:

(1) Consists of an education and training program in the form of instructional materials to assist employers in fulfilling the requirements of Section 502.009; and

(2) includes the development and distribution of a supply of informal leaflets concerning employers duties, employee rights, the outreach program, and the effects of hazardous chemicals.

(b) The director may contract with a public institution of higher education or other public or private organization to develop and implement the outreach program.

(c) The director shall develop and provide to each employer a suitable form of notice providing employees with information relating to employee rights under this chapter.

(d) The director shall publicize the availability of information to answer inquiries from employees, employers, or the public in this state concerning the effects of hazardous chemicals.

(e) In cooperation with the director, an employer may provide an outreach program in the community.

Texas Department of Health Outreach Program (Proposed): As the forgoing program materials are developed and become available through the Texas Department of Health, utilization of this assistance can be requested through the OEHS or directly through the Texas Department of Health:

TEXAS DEPARTMENT OF HEALTH

HAZARD COMMUNICATION PROGRAM
DIVISION OF OCCUPATIONAL HEALTH

1100 WEST 49th STREET	(512) 834-6600
AUSTIN, TEXAS 78756	TEX-AN 241-6600
OFFICE: 8407 WALL STREET	FAX (512) 834-6644
	TOLL FREE 1-800-452-2791

PART VI: EMPLOYEE EDUCATION PROGRAM

Sec. 502. 009. (THCA)

(a) An employer shall provide an education and training program for employees who use or handle hazardous chemicals.

(b) An employer shall develop, implement, and maintain at the workplace a written hazard communication program for the workplace that describes how the criteria specified in this chapter will be met.

(c) An education and training program must include, as appropriate:

(1) information on interpreting labels and MSDSs and the relationship between those two methods of hazard communication;

(2) the location by work area, acute and chronic effects, and safe handling of hazardous chemicals known to be present in the employees' work area and to which the employees may be exposed;

(3) the proper use of protective equipment and first aid treatment to be used with respect to the hazardous chemicals to which employees may be exposed; and

(4) general safety instructions on the handling, cleanup procedures, and disposal of hazardous chemicals.

(d) Training may be conducted by categories of chemicals. An employer must advise employees that information is available on the specific hazards of individual chemicals through the MSDSs. Protective equipment and first aid treatment may be by categories of hazardous chemicals.

(e) An employer shall provide additional instruction to an employee when the potential for exposure to hazardous chemicals in the employee's work area increases significantly or when the employer receives new and significant information concerning the hazards of a chemical in the employee's work area. The addition of new chemicals alone does not necessarily require additional training.

(f) An employer shall provide training to a new or newly assigned employee before the employee works with or in an area containing a hazardous chemical.

(g) An employer shall keep the written hazard communication program and a record of each training session given to employees, including the date, a roster of the employees who attended, the subjects covered in the training session, and the names of the instructors. Those records shall be maintained for at least 5 years by the employer. The department will have access to those records and may interview with employees during inspections.

(h) Emergency service organizations shall provide, to their members or employees who may encounter hazardous chemicals during an emergency, information on recognizing, evaluating, and controlling exposure to the chemicals.

In order to comply with the "Employee Education Program" requirements of the Texas Hazard Communication Act, The following HazCom training programs **(which include one for laboratories)** are established for The University of Texas at Austin for the education of its employees:

A. NEW EMPLOYEE HAZARD COMMUNICATION ORIENTATION:

All new employees of the University, both full or part time, shall be given instruction in the basic provisions of the Texas Hazard Communication Act at the time of their "benefits" orientation, normally held during the initial month of their employment. This briefing will be given by a staff member from the Office of Environmental Health and Safety and these orientations are conducted at the Office of Human Resources, located at 2613 Wichita Street.

B. INSTRUCTOR HAZARD COMMUNICATION COURSE:

Supervisors or other personnel assigned the responsibility of holding Employee Hazard Communication ("work area") training are required to attend the Instructor Hazard Communication Training Course conducted by the Office of Environmental Health and Safety. Pre-registration with the OEHS is required for this training in order that "work area specific" information can be prepared and highlighted during this training. Each Instructor will be issued a Hazard Communication Training notebook for use both in training and in maintaining required training records.

C. EMPLOYEE HAZARD COMMUNICATION TRAINING ("WORK AREA SPECIFIC"):

1. HazCom Instructors will conduct the work area specific training for all employees within their operations who work with or otherwise might be exposed to hazardous chemicals. New employees must be trained before being required to work with, or being exposed to, hazardous chemicals. In addition, representatives from the OEHS will assist the HazCom instructor, if requested, in presenting the general aspects of the Texas Hazard Communication Act (an explanation of Material Safety Data Sheets, labeling, written plan, etc.).

2. Employee Hazard Communication Training must include instruction in the areas outlined in Sec. 502.009 which include:

   - information on labeling and MSDSs;

   - the location of hazardous chemicals by work area and their associated healtheffects;

   - the proper use of personal protective equipment and first aid treatment in the case of overexposure; and

   - general instructions on handling, cleanup and disposal of hazardous chemicals.

In addition, this employee training may be augmented with education training programs and materials provided by or available from the Texas Department of Health "Outreach Program".

3. Summaries of video programs which deal with various aspects of Hazard Communication are available through the Office of Environmental Health and Safety and are included in Appendix B. While these videos are often helpful in the holding of Hazard Communication Act training, University Instructors must understand that these media are not "stand alone" programs and that, of themselves, they do not satisfy compliance with Hazard Communication training requirements.

D. LABORATORY TRAINING

Training for laboratory personnel is also being conducted by OEHS. This training includes: Chemical Hazards; Biological Hazards; Personal Protective Equipment; Laboratory Safety Equipment; Hazard Communication Act; Waste Management; and Emergency Procedures and Response. This education program is intended to meet the training requirements for laboratories as listed in Section 502.004 (f) (2) (B).

E. TRAINING RECORDS

Training in any of the preceding four categories shall be documented on the Texas Hazard Communication Training Record form (available from OEHS) and a copy of which shall be forwarded to the Office of Environmental Health and Safety. These records shall be maintained for at least 30 years. A copy of the Training form is listed as Appendix B.

PART VII: EMPLOYEE NOTICE; RIGHTS OF EMPLOYEES

Sec. 502. 017. (THCA)

(a) An employer shall post and maintain adequate notice, at locations where notices are normally posted, informing employees of their rights under this chapter. If the director does not prepare the notice under Section 502. 008., the employer shall prepare the notice.

(b) Employees who may be exposed to hazardous chemicals shall be informed of the exposure and shall have access to the workplace chemical list and MSDSs for the hazardous chemicals. Employees, on request, shall be provided with a copy of a specific MSDS with any trade secret information deleted. In addition, the employee shall receive training concerning the hazards of the chemicals and measures they can take to protect themselves from those hazards. Employees shall be provided with appropriate personal protective equipment. These rights are guaranteed.

(c) An employer may not discharge, cause to be discharged, otherwise discipline or in any manner discriminate against an employee because the employee has:

(1) filed a complaint;

(2) assisted an inspector of the department who may make or is making an inspection under Section 502.011;

(3) instituted or caused to be instituted any proceeding under or related to this chapter;

(4) testified or is about to testify in a proceeding under this chapter; or

(5) exercised any rights afforded under this chapter on behalf of the employee or on the behalf of others.

(d) Pay, position, seniority, or other benefits may not be lost as the result of the exercise of any right provided by this chapter.

(e) A waiver by an employee of the benefits or requirements of this chapter is void. An employer's request or requirement that an employee waive any rights under this chapter as a condition of employment is a violation of this chapter.

A. NOTICE TO EMPLOYEES:

1. “Notice to Employees”, as illustrated by the copy in Appendix C or as hereafter updated and revised by the Texas Department of Health, must be posted and maintained at locations within the “work area” and/or “workplace” where notices are normally posted.

2. “Notice(s) to Employees” are available from the Office of Environmental Health and Safety.

B. RIGHTS OF EMPLOYEES

1. Employees who may be exposed to hazardous chemicals shall be informed of the exposure and shall have access to the workplace chemical list and MSDSs for the hazardous chemicals. Employees, on request, shall be provided with a copy of a specific MSDS with any trade secret information deleted. In addition, the employee shall receive training concerning the hazards of the chemicals and measures they

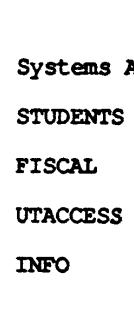
can take to protect themselves from those hazards. Employees shall be provided with appropriate personal protective equipment. These rights are guaranteed.

2. As an employer in the State of Texas, The University may not discharge, cause to be discharged, otherwise discipline, or in any manner discriminate against an employee because of the exercise of his or her rights under the Texas Hazard Communication Act.

APPENDICES

The University of Texas at Austin
Administrative Data Processing Systems

Type the name of a system (ST, FI, UT, or IN can be used) and press ENTER.



Systems Available:		Help line numbers:	
STUDENTS	- Student Tasks	Information Center	471-8800
FISCAL	- Fiscal Tasks	Terminal Hardware Problems	471-0007
UTACCESS	- Public Access	Computer System Status	471-4444
INFO	- UTCAT PLUS Information System (public access)	Personal Computers	471-8801
		Accounting - *DEFINE	471-8802

Unauthorized use is prohibited. Usage may be subject to security testing and monitoring. If you logon to this computer system, you acknowledge your awareness of and concurrence with Policy Memorandum 6.302 on Computer Security.

INFO

APPENDIX XV

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WELCOME TO THE "UTCAT PLUS" INFORMATION SYSTEM
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    ** NEW UTCAT ONLINE CATALOG AVAILABLE ** - select 1;
   Electronic Information Class Schedule, more news - select 8

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   0  UTCAT online catalog (OLD VERSION)
   1  UTCAT online catalog * NEW VERSION * with expanded searching
   2  Indexes to periodical articles...
   3  Encyclopedia
   4  Company Directory
   5  Material Safety Data Sheets
   6  Services: RENew books, request items (EXP, ILS, DOX, PUR)...
   7  Library hours
   8  UT Library News
   9  UT Austin information (directory, jobs, policies, equipment)...
  10  Log off now


   Type the number of your choice, then press ENTER.

-> 5
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APPENDIX XV

MSDS -- SEARCH CHOICES MENU

The Sigma-Aldrich Library of Material Safety Data Sheets (MSDS) containing information on approximately 72,000 chemical compounds, including inorganics, organics, and biochemicals.

COMMAND	EXAMPLES	DESCRIPTION
N = Name	n acetonitrile	Search by product name, synonym, or RTECS name
C = CAS number	c 75058	Search by Chemical Abstract Service (CAS) number
P = Product Catalog # ..	p sigma 175	Search by product catalog number

MSDS

Type a command, a space, and the words you want to search; then press ENTER
OR for search instructions/examples, type only the command, then press ENTER
-> N
Options: MENu HELp EXPlain NEWs COMment KEYs STOp=main menu

APPENDIX XV

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MSDS -- NAME SEARCH
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   Type the product's name, synonym, or RTECS name.

       EXAMPLES:   antimycin a3

                   blastmycin

                   blastomycin

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You are searching the MSDS database.

Type your search, then press ENTER.
OR if you want to choose another database, give the STOP command.
->

Or type:   HELp   MENu   COMment   STOp   then press ENTER
```

TEXAS HAZARD COMMUNICATION

TRAINING RECORD

In accordance with Section 10(a), Texas Hazard Communication Act, the individuals listed below have attended a training session covering the material as outlined in the provisions of the Act relating to the EMPLOYEE EDUCATION PROGRAM.

DATE:_____ TIME:_____ INSTRUCTOR:_____

	NAME (Print)	DEPARTMENT & Section	SSN	SIGNATURE
1.				
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3.				
4.				
5.				
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7.				
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NOTE: A copy must be sent to the Office of Environmental Health and Safety for record keeping purposes.

NOTICE TO EMPLOYEES

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

WORKPLACE CHEMICAL LIST

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

MATERIAL SAFETY DATA SHEETS

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

EMPLOYEE EDUCATION PROGRAM

Covered employees shall receive training by the employer on the hazards of the chemicals and on measures they can take to protect themselves from those hazards, and shall be provided with appropriate personal protective equipment. This training shall be provided as needed. Employers shall also provide training to new or newly assigned employees before the employees work with or in a work area containing a hazardous chemical.

LABELS

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

EXEMPTIONS

The following chemicals are exempt from coverage by this act: articles that do not normally release hazardous chemicals, food, drugs, cosmetics, hazardous waste, tobacco and tobacco products, wood or wood products, consumer products used in the same manner as normal consumer use, and radioactive waste.

REPORTING FATALITIES OR INJURIES

Employers must report to the department within 48 hours the occurrence of a chemical accident that results in one or more employee fatalities or results in the hospitalization of five or more employees.

EMPLOYEE RIGHTS

Employees may file complaints with the Texas Department of Health at the toll free number below, and may not be discharged or discriminated against in any manner for the exercise of any rights provided by this act.

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

Further information may be obtained from:

Texas Department of Health
Division of Occupational Health
Hazard Communication Branch
100 West 49th Street
Austin, Texas 78756

1-800-452-2791
(512) 834-6600
Tex-An: 241-6600

APPENDIX XV 1/94

This notice is subject to approval by the Texas Board of Health.