Laboratory Safety Manual

Environmental Health, Safety and Risk Management Department
P.O. Box 6113, SFA Station
Nacogdoches, Texas 75962-6113

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1. Introduction

All Laboratories using hazardous chemicals are required to comply with the Occupational Safety and Health Administration’s (OSHA) 29 CFR 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories. This standard requires that the employer develop a written chemical hygiene plan, which is capable of protecting employees from the health hazards associated with hazardous chemicals in the laboratory. This General Laboratory Safety Manual exceeds the purpose of writing a chemical hygiene plan.

A variety of hazards may exist in the laboratories at Stephen F. Austin State University. The risks associated with these hazards are greatly reduced or eliminated if proper precautions and practices are observed in the laboratory. To manage these risks, and in response to a heightened concern for safety in the workplace, the Environmental, Health, Safety & Risk Management Department at Stephen F. Austin State University has developed this Laboratory Safety Manual. This manual is intended to be a cornerstone of our SFASU safety program designed to aid faculty, staff and students in maintaining a safe environment in which to teach, conduct research and learn. The Laboratory Safety Manual applies to all laboratories at Stephen F. Austin State University and is intended to highlight those laboratory practices that are necessary for protecting students, staff, faculty and visitors from exposure to hazardous chemicals and potential dangers. Additionally, it is the job of the principal investigator to develop site specific standard operating procedures for all hazardous substances and potentially dangerous situations. If required, the Department of Environmental, Health, Safety & Risk Management will assist the respective facility or researcher to develop site specific procedures.
2. Responsibilities

The 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 they use. Every individual is responsible for conducting activities in a manner that will not endanger themselves and they must comply with the applicable requirements of state and federal laws as well as with university policies and procedures described in this manual. Occupational Safety and Health Administration (OSHA) defines a laboratory as “a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.” For laboratory workers refereed as employees, OSHA defines employee as “an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of their assignments.” An example of a laboratory worker would be a university teaching assistant, research assistant, professor, associate professor, assistant professor or any faculty member instructing an academic lab or conducting research in a lab. OSHA does not consider students in an academic laboratory as workers. However, as a matter of university safety and health policy, the principles, instructions and information outlined in this manual will apply to students in the laboratories of Stephen F. Austin State University. Also included, will be visiting professors and volunteers that might be working in the laboratory. Laboratory supervisors must ensure that these groups that are in the laboratories are adequately instructed in relation to safe laboratory practices. Laboratory supervisor or laboratory instructor in-charge is ultimately responsible for the safety of any person in their laboratory.

2.1 University-Wide Safety Responsibilities

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

2.2 The Department of Environmental Health, Safety & Risk Management

- Provide general laboratory 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 University in response to specific activities or areas of research.
- Undertake necessary enforcement actions to insure full compliance with all federal, state, local regulations and all institutional safety policies, up to and including independent authority to shut down laboratories for violations of these policies.
- Provide technical assistance to laboratory supervisors and workers concerning appropriate storage, handling and disposal of hazardous waste and chemicals.
- Provide assistance in hazardous material spill response services.
- Conduct fume hood testing and inspections.
- Provide technical assistance in laboratory construction, modification and renovation plans for safety design.
- Provide technical assistance concerning personal protective equipment and laboratory safety equipment.
- Maintain copies of laboratory safety training records, inspections, chemical inventory and MSDS.
- Provide guidance for maintaining compliance with federal, state, and local regulations as well as the procedures stated in this manual.
- Review and update the University’s lab manual at least annually.

2.3 College Dean

- Has the responsibility to insure the safe operations of all laboratories and other sites in the respective college where chemicals are used or laboratory procedures are conducted.
- Has the responsibility to 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.
- Appoint and delegate appropriate enforcement authority, if appropriate, to a college-wide laboratory safety officer (LSO) and authorize individual departmental chairs and directors to appoint and delegate appropriate enforcement authority to departmental chemical hygiene officers.
- Office of the Dean will maintain a current roster of all Laboratory Safety Officers and provide the names of these individuals to EHS&RM.
- Has the primary responsibility for the environmental health and safety of their staff and students.

2.4 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.
- Appoint and delegate appropriate enforcement authority to a departmental Laboratory Safety Officer. The department chair assumes all the responsibilities of the laboratory safety officer when there is not a specified laboratory safety officer.
2.5 Laboratory Safety Officer

The laboratory safety officers are the key to the success of the comprehensive laboratory safety program. As such they must effectively carry out the requirements of this manual. At a minimum, the laboratory safety officer will complete the following duties:

- Provide technical guidance and assistance regarding general lab safety, chemical safety policies and practices to the Dean, Department Chair, Director, Professors, Principal Investigators, Lab safety coordinators, Teaching Assistants, Supervisors, students and employees.
- Work with the above mentioned individuals to develop and implement the lab safety policies and practices outlined in this manual.
- Monitor compliance with policies and procedures for the procurement, safe use, and proper disposal of chemicals.
- Audit laboratories, evaluate hazards and document laboratory concerns to the principal investigator and the department of EHS&RM.
- Ensure that action is taken to correct laboratory practices and conditions identified as unacceptable on laboratory safety self evaluations and safety inspections.
- Recommend necessary training to laboratory faculty and staff.
- Respond to emergencies.
- Investigate and retain records of accidents involving laboratories.
- Conduct laboratory safety training sessions for laboratory personnel and upon request, assist Laboratory Supervisors, Principal Investigators and Faculty in developing and conducting hands-on training sessions with employees.

2.6 Principal Investigators and Laboratory Supervisors

- Assume direct responsibility for their laboratory’s compliance with the University Laboratory Safety Manual.
- 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.
- Train laboratory employees on how to find and use Material Safety Data Sheets.
- 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 evaluations.
- Complete and update annual laboratory chemical inventories.
- Provide site specific training on laboratory hazards.
• Have readily available a current copy of a Material Safety Data Sheet for all hazardous chemicals in the laboratory.
• Post emergency telephone numbers, Right to Know Poster and other posters supplied by EHS&RM in all laboratories.
• Forward documentation of training, inventories and accidents to EHS&RM.

2.7 Laboratory Employees and Students

• Maintain a thorough understanding and follow the laboratory policies and procedures in this manual and those contained in any supplementary information developed by the University in response to specific activities or areas of research for all purposes using chemical materials.
• Properly use and maintain personal protective equipment.
• Properly use and maintain 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 condition.
• Report all accidents, possible over exposures, or unsafe conditions to their supervisor.
• Attend Hazard Communication Act, Laboratory Safety, Fire Safety and all other applicable training sessions.
Stephen F. Austin State University
Laboratory Safety Officer

College/Department: ______________________________________________

Laboratory Safety Officer: _________________________________________

Laboratory Address: (Include all laboratories the LSO is assigned. Use additional paper if necessary)

Building: ____________________________________________

Room: ____________________________________________

Phone Number: ________________________________

P.O.BOX: ______________________________________

Each college/department or organized research unit that has laboratories must designate a Laboratory Safety Officer (LSO) to carry out the duties and responsibilities of the LSO described in the Laboratory Safety Manual.

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

Appointing Official:                                             Laboratory Safety Officer:

X

Dean, Department Chair, or Director                           X

Signature

A copy of this form shall be placed in the appropriate Lab Safety Manuals, retained in the Dean/Department Chair/Director’s office and submitted to the department of Environmental Health, Safety and Risk Management, P.O. BOX 6113, SFA Station, Nacogdoches, TX 75962.
3. General Laboratory Safety

3.1 Standard Operating Procedures

Standard operating procedures (SOPs) are detailed work practices, which are developed to provide guidance for the safe handling of hazardous chemicals. Site-specific standard operating procedures (SOPs) must be written for each potentially hazardous substance used in the laboratory. SOPs include but are not limited to procurement, distribution, storage, labeling, equipment usage, general lab practices, and disposal and emergency procedure practices for the particular chemical, work or hazard group. Information about each chemical can be obtained using the MSDS resource link posted on the EHS&RM department’s website.

The SOPs regarding various lab components provided in this manual offer generic safety guidelines for the laboratories on the campus of Stephen F. Austin State University. This document contains only a minimum set of guidelines, regulations, and recommendations required to maintain a safe working environment, and do not provide laboratory workers, research students, faculty and students with specific standard operating procedures necessary to work in their respective laboratories. It is the responsibility of the principal investigator or teaching faculty to develop specific standard operating procedures for their work place or laboratory.

3.1.1 General Safety Guidelines

The following guidelines have been established to minimize or eliminate hazards in the laboratory. These guidelines have also been provided to maintain a safe laboratory environment. It is the responsibility of each person that enters into the laboratory to understand the safety and health hazards associated with potential hazardous materials and equipment in the laboratory. It is also the individual’s responsibility to practice the following general safety guidelines at all times while working in the laboratories of Stephen F. Austin State University.

- Always wear proper eye protection in chemical work, handling and storage areas.
- Always know the hazards associated with the materials that are being utilized in the lab.
- Eyewashes should be flushed weekly and documented on eyewash tags.
- Properly label chemical waste with specific contents. Keep label attached to the container at all times. Always replace old and deteriorated labels.
- Keep chemical waste containers closed.
- Never remove chemicals, biological agents or any other laboratory related item from the laboratory without proper authorization.
- Never perform unauthorized work, preparations or experiments.
- Never engage in horseplay, pranks or other acts of mischief in chemical or biological work areas.
- Chemical fume hood sashes should be kept closed whenever possible. Maintain the minimum possible opening when working. Do not store chemicals in fume hoods.
- Do not store or consume food and drinks in labs or in any place where hazardous materials are either present or used.
• Food or drinks and chemicals should not be stored in the same refrigerator.
• Do not wear shorts or open-toed shoes in labs. Wear appropriate personal protective equipment when working in labs where hazardous materials are present.
• Always wash hands and arms with soap and water before leaving the work area. This applies even if you are wearing gloves.
• Remove clutter and practice good housekeeping.
• Confine long hair and loose clothing.
• Do not use cell phones, Bluetooth and MP3 players while working in the lab.
• Never leave an open flame unattended. Know the location of the nearest fire extinguisher. Never leave an experiment unattended while it is being heated or is rapidly reacting.
• Do not keep or work with flammable substances near a flame.
• Secure gas cylinders properly and keep safety caps on cylinders when not in use.
• Have appropriate spill supplies available and follow response procedures.
• Eliminate extension cords and power strips in series. No exposed wiring.
• Keep exits and aisles clear of obstructions.
• Emergency equipment should be clear of obstructions. Be familiar with the location of emergency equipment – fire alarm, fire extinguisher, emergency eye wash and safety shower. Know the appropriate emergency response procedures.
• Glass chemical bottles should not be stored on the floor.
• Do not store any lab equipment or chemicals in corridors.
• Keep equipment back from the edge of the lab bench to prevent spillage.
• Report any accident immediately, however minor or irrelevant you might think it might be.
3.2 Hazardous Chemicals and Hazard Communication Program

3.2.1 What are Hazardous Chemicals

A hazardous chemical is defined as: any element, chemical compound, or mixture of elements or compounds whose use could present a physical hazard or a health hazard. A physical hazard arises when use of a chemical is potentially dangerous due to the possibility of explosion, fire or violent reaction with other chemicals.

A physical hazard may be a:
- Flammable or Combustible liquid
- Compressed Gas
- Explosive
- Oxidizer
- Pyrophoric
- Unstable or Reactive
- Water Reactive

A health hazard is a chemical for which there is evidence that health effects may occur if employees are overexposed. A health hazard may be a:

- Carcinogen
- Toxic or highly toxic agent
- Reproductive toxin
- Irritant
- Corrosive
- Sensitizer
- Hepatotoxin
- Nephrotoxin
- Neurotoxin
- Hemototoxin
- Agent which damages the lungs, skin, eyes and mucous membranes.

The health effects caused by the above subcategories of chemicals may be acute or chronic. An acute effect is an adverse health effect that is the result of a short-term exposure to a high
concentration of a toxic material. An acute effect is usually felt immediately or with reactions occurring within two to three hours of overexposure. In the case of highly toxic materials, death may result even with prompt medical care. The most common type of exposure in laboratories is acute as a result of accidents and spills.

### 3.2.2 Hazard Communication Program

OSHA and Texas Hazard Communication Act require that a written Hazard Communication Program be developed, implemented and maintained at each work place. The department of Environmental Health, Safety & Risk Management has developed a Hazard Communication Program for Stephen F. Austin State University which can be accessed on the website of EHS&RM at [http://www2.sfasu.edu/safety/docs/hazard-communication.pdf](http://www2.sfasu.edu/safety/docs/hazard-communication.pdf).

According to the Texas Hazard Communication Act, the written program must address at minimum the following requirements:

- Information about workplace chemicals and hazards.
- Labels and other forms of warning for containers of hazardous chemicals.
- Material Safety Data Sheets (MSDS).
- Employee information and training.
- Reporting Fatalities and Injuries.
- Employee Rights.

### 3.3 Handling Practices

#### 3.3.1 Procurement

Before a substance is received, information on proper handling, storage, and disposal must be known to those who will be involved. Always refer to MSDS on the chemical for appropriate information. When procuring chemicals for the laboratory, less hazardous alternatives to chemicals used in various protocols should be discussed. By choosing suitable substitutes for hazardous chemicals, risk to laboratory personnel is reduced. Always discuss appropriate waste handling procedures for the chemicals purchased. The person who orders or uses the chemical is ultimately responsible for appropriate disposal of the chemical. Waste management costs for the chemicals should be included in the respective budgets. It is the responsibility of the person purchasing or using the chemical to pay for any waste management costs of the chemical.

Another consideration when procuring chemicals for the laboratory is duplication. If a lab with multiple researchers or users does not control ordering and maintain an accurate inventory, duplication of inventory items will result. This not only consumes lab storage space but also increases the amount of hazardous and flammable chemicals in the lab as well as increase spending and waste management costs.
3.3.2 Chemical Storage Area/ Stock Area

All chemicals must be segregated in a well-identified area with local exhaust ventilation. Chemicals, which are hazardous or 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 for replacement, deterioration, and container integrity. The labels must be checked to ensure they are still legible. If labels begin to fall off the container, secure them. If a label is becoming illegible, affix a new label to the container with the identity of the contents and hazards associated with it. Refer to Laboratory Chemical Storage section in this manual for compatibility and standard storage procedures.

3.3.3 Transportation and Distribution of Chemicals

When chemicals are hand carried, place the container in an outside (secondary) container. 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. When transporting chemicals on a cart, use a cart that is suitable for the load, and one that has high edges to contain leaks or spills. It is always recommended that you have hazardous chemical purchases delivered directly to the laboratory. If transporting large amounts of chemicals for a laboratory move, contact the department of Environmental Health, Safety and Risk Management at 468-6034 for consultation on safe packing, and compliance with federal, state and local laws.

3.3.4 Labeling and Signs

3.3.4.1 Labels

Container labeling can be a very effective method to communicate the physical and health hazards of chemicals used in laboratories. As per the Texas Hazard Communication Act, the chemical manufacturer, importer or distributor must ensure that each container of hazardous chemical is labeled, tagged or marked with the following three elements of information:

- Identity of the Chemical,
- Appropriate Hazard Warnings and
- Name and Address of the manufacturer, distributor or responsible party.

The containers that you receive directly from the manufacturer or distributor are called primary containers. These primary containers usually have appropriate labeling and contain the above mentioned information.

- All chemical containers must be labeled.
- All labels must be legible in English and include chemical/product name. Chemical formulas are not acceptable.
- Whenever required they should include information related to relevant hazards.
- Labels on incoming containers must not be removed or defaced.
• Date all peroxidizable and other chemicals, which may become unstable over time. When required include the information.
• Waste chemical containers must be clearly marked “Hazardous Waste” indicating specific name of waste chemical and date when full.
• All secondary containers should be labeled and include all the essential components of labeling just like primary containers.

3.3.4.2 Signs

Each laboratory door must be legibly marked with the following information:
• Room Number
• Laboratory Supervisor’s name
• Emergency contacts, including names, office location, and emergency telephone numbers

Every laboratory should visibly post the following signs and posters:
• Employee Right to Know poster
• Emergency Contact Information
• Common lab problems or general lab instructions poster
• Special hazards/emergency instructions when appropriate
• Location signs for safety equipment, first aid equipment and exists: Contact the department of Environmental Health, Safety & Risk Management for assistance.
• Areas where food and beverage consumption and storage are permitted.
• Warning signs at areas or equipment where special or unusual hazards exist like excessive flammables or fragile equipment.

3.3.5 Material Safety Data Sheets (MSDS)

Material Safety Data Sheets provide valuable information on hazardous chemicals and must be stored in an orderly fashion and readily available for all chemicals in the laboratory. The MSDS information is useful for establishing parameters for a safe workplace and is invaluable if emergencies involving the chemical occur. It is the responsibility of the laboratory supervisor to maintain the MSDS and have appropriate instructions to find them in the need of emergency or special situations like spills. A copy of the MSDS has to be submitted to the department of Environmental Health, Safety & Risk Management along with the annual chemical inventory list. For every new chemical purchased the MSDS list has to be updated with the EHS&RM.

A Material Safety Data Sheet (MSDS) is a document that contains information on the potential hazards (health, fire, reactivity and environmental) and how to work safely with the chemical product. It is an essential starting point for the development of a complete health and safety program. It also contains information on the use, storage, handling and emergency procedures.
all related to the hazards of the material. The MSDS contains much more information about the material than the label. MSDSs are prepared by the supplier or manufacturer of the material. It is intended to tell what the hazards of the product are, how to use the product safely, what to expect if the recommendations are not followed, what to do if accidents occur, how to recognize symptoms of overexposure, and what to do if such incidents occur.

If you do not have the MSDS for any chemical:

- Call the manufacturer
- Click on the free MSDS link on the website of EHS&RM ([http://hq.msdsonline.com/sfasu/Search/Default.asp](http://hq.msdsonline.com/sfasu/Search/Default.asp))
- For further assistance call EHS&RM at 468-6034

A MSDS usually will have the following structure: (some MSDS might provide more information)

1. Chemical Identity or Name.
2. Manufacturer's name, address, telephone number and emergency telephone number. Date the MSDS was prepared and an optional signature of the preparer.
3. Lists the hazardous components by chemical identity and other common names. Includes OSHA PEL (Permissible Exposure Limit), ACGIH TLV (Threshold Level Value) and other recommended exposure limits.
4. Physical/Chemical Characteristics like boiling point, vapor pressure, vapor density, specific gravity, melting point, evaporation rate, solubility in water, physical appearance and odor.
5. Fire and explosion hazard data, flash point (and method used to determine it), flammability limits, extinguishing media, special firefighting procedures, unusual fire and explosion hazards.
6. Reactivity Data like Stability, conditions to avoid, incompatibility (materials to avoid), hazardous decomposition or byproducts, hazardous polymerization (and conditions to avoid).
7. Health hazard data like routes of entry (inhalation, skin, ingestion), health hazards (acute = immediate and chronic = build up over time), carcinogenicity (NTP, IARC monographs, OSHA regulated), signs and symptoms of exposure, medical conditions generally aggravated by exposure, emergency and first aid procedures.
8. Precautions for safe Handling and use, like Steps to be taken in case material is released or spilled, waste disposal method, precautions to be taken in handling or storage, other precautions.
9. Control measures like respiratory protection (specify type [see respirators], ventilation (local, mechanical exhaust, special or other), protective gloves, eye protection, other protective clothing or equipment, work/hygienic practices.
3.4 Laboratory Chemical Storage and Inventory

Proper storage of chemicals in laboratories is always a major concern. Chemicals that have been stored improperly could react, forming hazardous products. Sometimes improper storage results only in disorder, but at other times, it has resulted in loss of life and property. Each department is responsible for safely managing chemical supplies and complying with all federal, state and local regulations.

- Chemicals should never be stored en masse by the alphabet as this will automatically introduce chemical incompatible storage situations. Only with the segregation groups can chemicals be stored in alphabetic order.
- If a chemical exhibits more than one hazard, segregate by using the characteristic that exhibits the primary hazard. Sometimes, classes of incompatible materials may be stored in proximate storage with other chemicals if secure secondary containments are used to prevent incompatible reactions. Incompatible chemicals stored near each other are unprotected in the event of fire.
- Always read the label and MSDS carefully before storing a chemical. The MSDS for most materials lists incompatibilities for that chemical.
- Do not store chemicals near heat sources or in direct sunlight.
- Date chemicals when received and first opened. Always use the old chemicals first which will reduce the amount of chemicals for disposal.
- Keep in mind the expiration dates for chemicals.
- Never use lab benches as permanent storage areas for chemicals.
- Inspect chemicals regularly for any signs of deterioration and for the integrity of the label. Never wait till the chemical becomes unknown. It is against the law to store or use unidentified chemicals in the laboratories or workplace.
- Never store chemicals in glass containers on the floors or on the edge of shelves. All shelves that carry chemicals should have lips (raised edges) to prevent any spillage or overturns.
- Do not use fume hoods as a permanent storage location for the chemicals, with the exception of particularly odorous chemicals that may require ventilation.
- Please contact the department of Environmental Health, Safety & Risk Management at 468-6034 for any disposal of old, outdated or unused chemicals.
- Never store chemicals above the eye level. If there is a leak or breakage, the contents will fall onto your face and upper body.
- Chemicals that need refrigeration must be sealed with tight fitting caps and kept in laboratory safe refrigerators. Do not clutter the refrigerators with stored chemicals.
- Never store flammable liquids in a standard or domestic refrigerator or freezer. They have numerous ignition sources that could ignite vapors.
- Do not store excessive amounts of chemicals in the lab. Unnecessary storage of chemicals is a fire hazard and limits work place. It also increases the waste generated and thus waste disposal costs. The disposal costs of chemicals stored for long time often exceed any cost savings from prolonged or excessive quantity storage.
3.4.1 Chemical Compatibility Guide

All facilities and departments at Stephen F. Austin State University are responsible for safely managing chemical supplies and complying with fire code allowances in areas under their purview. An important rule of chemical storage is to segregate incompatible chemicals which, if accidentally mixed, could cause fire, explosion, or the generation of toxic gases. Hazardous chemical reactions can occur from improper storage when incompatible materials mix because of:

- Accidental breakage
- Container failure
- Fires and earthquakes
- Mixing of gases or vapors from poorly closed containers
- Mistakenly storing incompatibles together because of improperly labeled containers

3.4.1.1 Partial List of Incompatible Chemicals

Below list is an example of incompatible chemicals. Substances in the left hand column should be stored and handled so that they cannot accidentally contact corresponding substances in the right hand column under uncontrolled conditions.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Separate From</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>Chromic acid, nitric acid, peroxides, permanganates</td>
</tr>
<tr>
<td>Acetic anhydride</td>
<td>Hydroxyl-containing compounds such as ethylene glycol, Perchloric acid</td>
</tr>
<tr>
<td>Acetone</td>
<td>Concentrated nitric and sulfuric acid mixtures, hydrogen peroxide</td>
</tr>
<tr>
<td>Acetonitrile</td>
<td>Strong acids and bases</td>
</tr>
<tr>
<td>Acetylene</td>
<td>Chlorine, bromine, copper, silver, fluorine, mercury</td>
</tr>
<tr>
<td>Alkali and alkaline earth metals,</td>
<td>Carbon dioxide, carbon tetrachloride, other chlorinated hydrocarbons (also prohibit the use of water, foam, and dry chemical extinguishers on fires involving these metals—dry sand should be employed)</td>
</tr>
<tr>
<td>such as sodium, potassium, lithium,</td>
<td></td>
</tr>
<tr>
<td>magnesium, calcium, powdered aluminum</td>
<td></td>
</tr>
<tr>
<td>Ammonia (anhydrous)</td>
<td>Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrogen fluoride</td>
</tr>
<tr>
<td>Ammonium hydroxide</td>
<td>Strong acids, hydrogen peroxide, acidic metals</td>
</tr>
<tr>
<td>Aniline</td>
<td>Nitric acid, hydrogen peroxide</td>
</tr>
<tr>
<td>Chromic acid and chromium trioxide</td>
<td>Acetic acid, naphthalene, camphor, lycerol, turpentine, alcohol, other flammable liquids</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Ammonia, acetylene, butadiene, butane, other petroleum gases, hydrogen, sodium carbide, turpentine benzene, finely divided metals</td>
</tr>
<tr>
<td>Substance</td>
<td>Combinations</td>
</tr>
<tr>
<td>---------------------------</td>
<td>----------------------------------------------------------------</td>
</tr>
<tr>
<td>Chloroform</td>
<td>Alkali metals (e.g. sodium, potassium), acetone, strong bases</td>
</tr>
<tr>
<td>Copper</td>
<td>Acetylene, hydrogen peroxide</td>
</tr>
<tr>
<td>Fluorine</td>
<td>Isolate from everything</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>Nitric acid, sulfuric acid, hydrochloric acid, Perchloric acid,</td>
</tr>
<tr>
<td></td>
<td>anhydrides, inorganic acids</td>
</tr>
<tr>
<td>Hydrazine</td>
<td>Hydrogen peroxide, nitric acid, any other oxidant</td>
</tr>
<tr>
<td>Hydrocarbons (benzene,</td>
<td>Fluorine, chlorine, bromine, chromic acid, peroxides</td>
</tr>
<tr>
<td>butane, propane, gasoline,</td>
<td></td>
</tr>
<tr>
<td>turpentine, etc.)</td>
<td></td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>Strong bases, permanganates, chlorates, chlorites</td>
</tr>
<tr>
<td>Hydrocyanic acid</td>
<td>Nitric acid, alkalis</td>
</tr>
<tr>
<td>Methanol</td>
<td>Perchloric acid, sulfuric acid, nitric acid, highly reactive</td>
</tr>
<tr>
<td></td>
<td>metals (e.g., potassium, sodium, magnesium)</td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>Acetic anhydride, acetone, Acetonitrile, alcohols, thiols,</td>
</tr>
<tr>
<td></td>
<td>amines, dichloromethane, DMSO, benzene, bases</td>
</tr>
<tr>
<td>Phenol</td>
<td>Nitric acid, Perchloric acid, sulfuric acid</td>
</tr>
<tr>
<td>Pyridine</td>
<td>dinitrogen tetroxide, acid chlorides, anhydrides, Perchloric</td>
</tr>
<tr>
<td></td>
<td>acid</td>
</tr>
</tbody>
</table>
### 3.4.1.2 Classes of Incompatible Chemicals

<table>
<thead>
<tr>
<th>A are incompatible with</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkali and alkaline earth</td>
<td>Water</td>
</tr>
<tr>
<td>• Carbides</td>
<td>Acids</td>
</tr>
<tr>
<td>• Hydrides</td>
<td>Halogenated organic compounds</td>
</tr>
<tr>
<td>• Hydroxides</td>
<td>Halogenating agents</td>
</tr>
<tr>
<td>• Metals</td>
<td>Oxidizing agents</td>
</tr>
<tr>
<td>• Peroxides</td>
<td></td>
</tr>
<tr>
<td>Azides, inorganic</td>
<td>Acids</td>
</tr>
<tr>
<td></td>
<td>Heavy metals and their salts</td>
</tr>
<tr>
<td></td>
<td>Oxidizing agents</td>
</tr>
<tr>
<td>Cyanides, inorganic</td>
<td>Acids</td>
</tr>
<tr>
<td></td>
<td>Strong bases</td>
</tr>
<tr>
<td>Nitrates, inorganic</td>
<td>Acids</td>
</tr>
<tr>
<td></td>
<td>Reducing agents</td>
</tr>
<tr>
<td>Organic compounds</td>
<td>Oxidizing agents</td>
</tr>
<tr>
<td>• Organic acyl halides</td>
<td>Bases</td>
</tr>
<tr>
<td></td>
<td>Organic hydroxy and amino compounds</td>
</tr>
<tr>
<td>• Organic anhydrides</td>
<td>Bases</td>
</tr>
<tr>
<td></td>
<td>Organic hydroxy and amino compounds</td>
</tr>
<tr>
<td>Organic halogen compounds</td>
<td>Group IA and IIA metals</td>
</tr>
<tr>
<td></td>
<td>Aluminum</td>
</tr>
<tr>
<td>Organic nitro compounds</td>
<td>Strong bases</td>
</tr>
<tr>
<td>Oxidizing agents</td>
<td>Reducing agents</td>
</tr>
<tr>
<td>Chlorates</td>
<td>Ammonia, anhydrous and aqueous</td>
</tr>
<tr>
<td>Chromates</td>
<td>Carbon</td>
</tr>
<tr>
<td>Chromium trioxide</td>
<td>Metals</td>
</tr>
<tr>
<td>Dichromates</td>
<td>Metal hydrides</td>
</tr>
<tr>
<td>Halogens</td>
<td>Nitrites</td>
</tr>
<tr>
<td>Halogenating agents</td>
<td>Organic compounds</td>
</tr>
<tr>
<td>Hydrogen peroxide</td>
<td>Phosphorus</td>
</tr>
<tr>
<td>Nitric acid</td>
<td>Silicon</td>
</tr>
<tr>
<td>Nitrites</td>
<td>Sulfur</td>
</tr>
<tr>
<td>Reducing agents</td>
<td>Oxidizing agents</td>
</tr>
<tr>
<td></td>
<td>Arsenates</td>
</tr>
<tr>
<td></td>
<td>Arsenites</td>
</tr>
<tr>
<td></td>
<td>Phosphorus</td>
</tr>
<tr>
<td></td>
<td>Selenites</td>
</tr>
<tr>
<td></td>
<td>Selenates</td>
</tr>
<tr>
<td></td>
<td>Tellurium salts and oxides</td>
</tr>
<tr>
<td>Sulfides, inorganic</td>
<td>Acids</td>
</tr>
</tbody>
</table>
3.4.2 Flammables

Flammable materials include aerosols, gases, liquids, and solids. In most laboratory situations, gases, liquids, and solids will be the main concern. Flammable gases are defined by OSHA to be “(A) a gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13% 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% by volume, regardless of the lower limit.” Flammable liquids mean any liquid having a flashpoint below 100°F. Flammable solid means “a solid, other than a blasting agent or explosive, that is liable to cause fire through friction, absorption of moisture, spontaneous chemical change, or which burns so vigorously and persistently as to create a serious hazard.” The Material Safety Data Sheet is a good source for determining if a chemical is flammable. In addition, most flammable substances are labeled as such.

For the purpose of this manual we will define a solvent as any flammable or combustible liquid with a flash point below 200°F. The flash point of a liquid is the lowest temperature at which a liquid gives off vapor at such a rate to form an air & vapor mixture that will ignite, but will not sustain ignition. Flammable liquids are indeed the most common chemicals found in a laboratory. It is the vapor of a flammable liquid, not the liquid itself that ignites and causes a fire.

Examples of flammable liquids with flashpoint less than 100°F: All alcohols, acetone, acetaldehyde, acetonitrile, amyl acetate, benzene, cyclohexane, dimethyldichlorosilane, dioxane, diethyl ether, ethyl acetate, histoclad, hexane, hydrazine, methyl butane, picolene, piperidine, pyridine, some scintillation liquids, all silanes, tetrahydrofuran, toluene, triethylamine, and xylene.

- Any solvent not in a flammable liquid storage cabinet or safety can is considered to be unprotected.
• A flammable cabinet is a metal cabinet meeting the design and construction requirements of NFPA 30 and have been tested and listed by third parties like Factory Mutual Laboratories.
• Glass containers storing flammables should be limited to 1 pint in size whenever practical. When not in use, they should be stored in a flammable liquid storage cabinet.
• Transferring of solvents should always be done in a laboratory hood or an approved bulk storage room.
• Flammable liquid storage cabinets shall not be located near exit doorways, stairways, or in a location that would impede egress.
• Flammable liquid storage cabinets must not be wall mounted or stored on top of benches. Installation of any compact wall mounted cabinets should be approved by the department of Environmental Health, Safety and Risk Management.
• Laboratory design must ensure that flammable liquid storage cabinets are not located near an open flame or other ignition source.
• When flammable or combustible liquids present multiple hazards, the laboratory shall address the storage requirements for each hazard. Example: Acetic acid which is a corrosive and flammable material, when stored in a flammable cabinet with other flammable materials; it must be segregated through the use of separate barriers like secondary containment.
• Incompatible flammable materials should not be stored within the same cabinet.
• Minimize the amount of flammables stored in the lab.
• Never store flammable chemicals in a standard household refrigerator.
• Flammable liquid storage cabinets shall be conspicuously labeled in red letters on contrasting background “FLAMMABLE – KEEP FIRE AWAY.” In other cases, the labeling should at least clearly and highly visibly indicate that the cabinet has flammable materials and thus is a fire hazard.
3.4.3 Corrosives

Corrosive materials are those that cause visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. Corrosives are most commonly acids and alkalis, but many other materials can be severely damaging. Strong oxidizing materials can also cause burns and damage to the eyes and skin. 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. Examples of these materials are lithium chloride, halogen fluorides, and allyl iodide. 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 to water. MSDS are very helpful to find out if a chemical is corrosive.

- Always store acids separately from bases.
- Store acids in acid storage cabinets away from flammables since many acids are strong oxidizers.
- Never store corrosives above eye level and store them on a low shelf or cabinet.
- Corrosives stored in ordinary metal cabinet will quickly damage it. Store corrosives in a wooden cabinet or one that is corrosion resistant.
- Nitric acid should be stored in a separate cabinet or compartment.

3.4.3.1 Mineral Acids

Oxidizing: Examples: Sulfuric acid, Nitric acid, Chromic acid, Perchloric acid etc.

- Store separately from organic acids.
- Highly reactive with most substances.
- Perchloric acid presents special hazards. Take precautions to isolate it from acetic anhydride, bismuth and its alloys, alcohol, paper, wood, oil, ether, grease, and sulfuric acid. Never keep it near acetic acid.

Non Oxidizing: Examples: Hydrochloric, hydrofluoric, phosphoric, hydroiodic.

- Hydrofluoric is extremely hazardous and requires special attention. It can cause severe burns and inhalation of anhydrous hydrogen fluoride can be fatal.
- Always use hydrofluoric acid in a properly functioning fume hood and always wear personal protective clothing.
- Never store it in a glass container as it is incompatible with glass. Store it separately in an acid storage cabinet and keep only the required amount in lab.
- If you come in contact with hydrofluoric acid, promptly seek medical attention.
3.4.3.2 Organic Acids

Examples: Acetic acid, Butyric acid, Formic acid, Propionic acid.

- Store separately from oxidizing mineral acids.
- Corrosive to metal surfaces.
- Store in a ventilated corrosive storage cabinet if possible.
- Can be stored with organic solvents unless otherwise stated on the MSDS.
- Keep Perchloric acid away from acetic acid.

3.4.4 Oxidizers

Oxidizers are agents that initiate or promote combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases. Depending on the class of the chemical, an oxidizing material may increase the burning rate of combustibles with which it comes in contact and cause the spontaneous ignition of combustibles with which it comes in contact or undergo an explosive reaction when exposed to heat, shock or friction.

Oxidizers are generally corrosive.

Examples: Peroxides, Nitrates, Nitrites, Perchlorates, Chlorates, Chlorites, Hypochlorites, Dichromates etc

- Oxidizers form explosive combinations with flammable or combustible material. For this reason, they should be stored away from solvents, organic compounds, and combustible materials and in a cool, dry location.
- Never store them under the sink.
- 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.
- Perchloric acid is an oxidizing agent of particular concern. Whenever possible, substitute a less hazardous chemical for Perchloric acid.
- 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.
3.4.5 Water Reactive Materials

Water reactive materials are chemicals, which react violently with water to produce heat and flammable or toxic gas. They 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:

Alkali metals like lithium, sodium, potassium, Alkali metal hydrides, Alkali metal amides, Metal alkyls such as lithium alkyls and aluminum alkyls, Grignard reagents, Magnesium, Silanes, Zinc, Aluminum, Anhydrous metal halides like AlCl3, TiCl4, ZrCl4, SnCl4, Halides of non metals like POCL3, SOCI2, SO2 Cl2, Halides of non metals like BCl3, BF3, PCl3, PCl5, Phosphorous pentoxide, Calcium Carbide, Organic acid halides and anhydrides of low molecular weight.

3.4.6 Pyrophoric Materials

Pyrophoric means a chemical that will ignite spontaneously in air at temperature of 130°F (54°C) or below.

*Classes of Pyrophoric Chemicals:*
Grignard reagents, RMgX
Metal alkyls and aryls, such as RLi, RNa, R 3 Al, R 2 Zn
Metal carbynls, such as Ni(CO)4 , Fe(CO)5 , Co 2 (CO)8
Alkali metals such as Na, K
Metal powders, such as Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr
Metal Hydrides, such as NaH, LiAlH 4
Nonmetal hydrides, such as B 2 H 6 and other boranes, PH 3 , AsH 3
Nonmetal alkyls, such as R 3 B, R 3 P, R 3 As
Phosphorus (white)
Peroxide forming materials are chemicals that react with air, moisture, or impurities for form peroxides. The tendency to form peroxides is greatly increased by evaporation or distillation. Peroxide forming materials can form shock sensitive peroxide crystals over time or upon exposure to air. Organic peroxides are extremely sensitive to shock, sparks, heat, friction, impact, and light. They are very unstable and some chemicals that can form them are commonly used in laboratories. The most common peroxide forming chemicals in use are diethyl ether and tetrahydrofuran (THF). Peroxide formation cannot be prevented once the chemical has been opened unless the chemical is maintained under an inert atmosphere (impractical). For this reason, it is recommended that all peroxide formers be dated when received, and periodically evaluated using test strips to indicate peroxide formation. It is prudent practice to maintain only the inventory necessary to complete ongoing work. DO NOT STOCKPILE! The Material Safety Data Sheet is a good source for determining if a material is capable of forming peroxides.

- Do not open the chemical container if peroxide formation is suspected. 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.
- 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 disposed after one year.
- Store all peroxide forming materials away from heat, sunlight, and sources of ignition. Sunlight accelerates the formation of peroxides.
- Secure the lids and caps on these containers to discourage the evaporation and concentration of these chemicals.
- Never store these chemicals in glass containers with screw cap lids or glass stoppers. Friction and grinding must be avoided. Also, never store them in a clear glass bottle where they would be exposed to light.
**Classes of Chemicals That Can Form Peroxides Upon Aging**

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

<table>
<thead>
<tr>
<th>Organic</th>
<th>Inorganic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylic acid</td>
<td>Tetrafluoroethylene</td>
</tr>
<tr>
<td>Acrylonitrile</td>
<td>Vinyl acetate</td>
</tr>
<tr>
<td>Butadiene</td>
<td>Vinyl acetylene</td>
</tr>
<tr>
<td>Chlorobutadiene</td>
<td>Vinyl chloride</td>
</tr>
<tr>
<td>Chlorotrifluoroethylene</td>
<td>Vinyl pyridine</td>
</tr>
<tr>
<td>Methyl methacrylate</td>
<td>Vinylidene chloride</td>
</tr>
<tr>
<td>Styrene</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetal</td>
<td></td>
</tr>
<tr>
<td>Cumene</td>
<td>Ethylene glycol dimethyl ether (glyme)</td>
</tr>
<tr>
<td>Cyclohexene</td>
<td>Furan</td>
</tr>
<tr>
<td>Cyclooctene</td>
<td>Methyl acetylene</td>
</tr>
<tr>
<td>Cyclopentene</td>
<td>Methyl cyclopentane</td>
</tr>
<tr>
<td>Diacetylene</td>
<td>Methyl-i-butyl ketone</td>
</tr>
<tr>
<td>Dicyclopentadiene</td>
<td>Tetrahydrofuran</td>
</tr>
<tr>
<td>Diethylene glycol dimethyl ether (diglyme)</td>
<td>Tetrahydronaphthalene</td>
</tr>
<tr>
<td>Diethyl ether (ether)</td>
<td>Vinyl ethers</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Organic</th>
<th>Inorganic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divinyl ether</td>
<td>Potassium metal</td>
</tr>
<tr>
<td>Divinyl acetylene</td>
<td>Potassium amide</td>
</tr>
<tr>
<td>Isopropyl ether</td>
<td>Sodium amide (sodamide)</td>
</tr>
<tr>
<td>Vinylidene chloride</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Lists are illustrative but not exhaustive.
3.4.8 Compressed Gas Cylinders

Compressed gas cylinders in the laboratory pose both chemical and physical hazards. These cylinders are safe under normal use; however, serious accidents have resulted from the misuse, abuse, or improper handling of compressed gases. If a valve is damaged as the result of the tank being knocked over, the cylinder can become a projectile causing severe injury. Some gases also present a fire hazard due to their high degree of flammability.

- Use cylinders in an upright position, unless equipment manufacturer provides specific instructions otherwise.
- Turn all valves off when not in use.
- Do not modify relief valves.
- Know the contents, properties, and health hazards associated with the contents. Contents must be clearly labeled.
- Notify distributor immediately of any problems in the operation or condition of the cylinder (e.g. dents).
- Ensure all hardware connecting the cylinder to receiver is compatible with the pressure and contents to which it is exposed always use the correct gauge for the pressure and chemical to which it is exposed.
- Select the smallest reusable cylinder compatible with the need.
- Always release pressure from regulator before disconnecting.
- Emergencies: in the event of a cylinder emergency such as a significant leak, evacuate the area, shut the door, and call 911.
- Always return compressed gas cylinders when finished. If cylinders cannot be returned to supplier, contact the department of Environmental Health, Safety and Risk Management at 468-6034. Cylinders stored for extended periods can result in heavy waste management costs.
- The valve protection cap should be left in place until the cylinder is secured and ready for use. Never struggle with a cylinder cap or use a screw driver to remove a cylinder cap. Do not drop cylinders or allow them to be struck with violent force.
- Secure cylinders in an upright position with proper chain, stand, or strap. Stored cylinders must have the valves closed and the valve covers must be in place.
- Never store cylinders of flammable gases (empty or full) near cylinders of oxygen or other oxidizers. A minimum separation of 20 feet or specially designed separation wall must be maintained. When practical, store cylinders a minimum of 20 feet from flammable liquids and away from sources of heat. If this is not practical, consult EHS&RM at 468-6034 for assistance.
- Never store cylinders in a means of egress.
- Clearly mark "empty" cylinders with tag or sign. Writing "MT" in chalk or on label is not acceptable. Separate "empty" and "full" cylinders to avoid confusion and do not store empty cylinders in your laboratory.
- Cylinders should not be placed, stored or used on sides unless recommended by manufacturer.
• Cylinders must be hydrostatically tested every 10 years. Note the last test date on
top of the cylinder. Notify the supplier immediately if outdated cylinders are
identified.
• Keep amount of flammable gases to a minimum. The number of flammable gas
cylinders (10"x50") must not exceed 3 cylinders per 500 square feet in a non-
sprinkled building or 6 cylinders per 500 square feet in a sprinkled building.
• Never rely on color-coding as a way to identify the compressed gas cylinder.
Color codes are for the owner's convenience.
• Transport cylinders in an upright position.
• Never roll or drag full or empty cylinders. Preferred transport method is to secure
cylinders (with valve covers in place) to a hand truck or similar mode of transport.
• Do not move a cylinder that has a regulator on it even if main tank valve is off.
• Treat "empty" cylinders with the same respect as "full" cylinders.
• Transport of cylinders via stairs is discouraged unless other means of upper floor
access is not available. When transporting cylinders via stairs, the cylinders must
be capped and secured in an upright position to a hand truck suitable for use on
stairs.

3.5 Exposure Control Measures

3.5.1 Chemical Fume Hoods

Chemical fume hoods are the most reliable and primary engineering control used in the
laboratory to protect against the inhalation of hazardous vapors and gases. A fume hood is a
partially enclosed workspace that is exhausted, in most cases, to the outside of the building. An
efficiently working fume hood minimizes a person’s exposure to airborne contaminants and
prevents them from reaching the breathing zone. It also provides protection from unanticipated
fires, explosions, and chemical splashes.

Optimum airflow, or face velocity, of a chemical fume hood is 80-120 feet per minute. This
range allows the hood to properly contain and exhaust contaminants, reduces the chance for
escape of fumes via turbulence and outside air movement. Face velocities below 80 fpm are
likely to allow contaminants to escape from the hood and face velocities above 120 fpm can
cause excessive turbulence and can also allow contaminants to escape.

The typical fume hood is made up of the following components:
• **Hood body** - The visible part of the chemical fume hood that serves to contain hazardous vapors & gases
• **Sash** – A sliding glass door or panel on the front of the hood that opens to allow access to the inside of the hood.
• **Airfoil** – Located along the bottom “lip” of the hood, the airfoil streamlines airflow into the hood and helps prevent turbulence that could cause vapor or gases to escape. When the sash is completely closed, the airfoil provides a source of air from the room for the hood to exhaust. It is important to note that removing the airfoil can cause turbulence and loss of containment
• **Work Surface** – The bench top or floor area where apparatus and equipment needed for experiments are placed.
• **Baffles** – The adjustable slates along the back of the hood body. They create openings along the back of the hood that help keep the airflow uniform across the sash opening.
• **Exhaust plenum** – Helps to distribute airflow evenly across the face of the hood.
• **Face** – The plane that runs from the bottom of the sash to the work surface. This plane is where the face velocity of the hood is measured.
(Copyright of the Eagleson Institute)

(Air is pulled in to the body of the hood through the opening of the sash and the airfoil. It travels back through the baffles and up through the top of the hood. The air is then exhausted out if the hood and building through ductwork.)

3.5.1.1 Types of fume hoods and their function

There are several types of fume hoods that are located within different types of laboratories. Each providing a unique function by design.

- **Constant Air Volume (CAV)/ Conventional Hood** – The volume of airflow within this type of hood remains constant. All air enters through the sash opening. As one lowers or raises the sash the velocity of the airflow increases and decreases respectively. It is very important to properly position the sash in order to maintain the optimum face velocity (80-120 feet per minute).

- **Bypass Hoods** – This type of hood is essentially the same as a conventional/CAV hood. The only difference is that it has an air bypass above the sash that provides an additional source of room air when the sash is closed. The bypass area becomes exposed as the sash is lowered, which reduces the rate of increase in the face velocity and reduces the chance for turbulence and loss of containment. As with the conventional/CAV hoods, it is important to properly position the sash in order to maintain a face velocity of 80-120fpm.

- **Auxiliary Air Hood** – This type of hood is similar to the bypass hood. The difference being that the source of the bypass air does not come from inside the lab but from a dedicated duct that brings in air from outside of the building. While this type of hood
saves energy by reducing the amount of air-conditioned or heated room air exhausted through the hood, it can cause discomfort for those working in or around the hood. It is important to remember to close the sash when the hood is not in use. This will allow the unconditioned air to bypass through the hood and reduce the effect on the temperature and humidity in the lab.

- Variable Air Volume (VAV) – These hoods are very sophisticated and have the ability to maintain a constant face velocity as the height of the sash is lowered and raised. The exhaust volume is adjusted when the sash is moved so that the average face velocity is maintained within set parameters. The sash of a VAV hood should be closed when not in use in order to conserve energy.

(Most hoods on campus are standard VAV hoods)

- Radioactive Hood – Any of the above listed hoods can also be used for radioactive materials. The only stipulation is that the interior work surface must be impervious (usually stainless steel). In some cases, the hood is also required to have a filter at the hood outlet that Radiation Safety is able to monitor.
Radiation Safety will mark hoods with the above sticker if they are approved for radioactive materials use.

- Perchloric Acid Hood – Perchloric acid will vaporize when heated above ambient temperatures. Once vaporized, it may condense in the hood, ducting, and fan components. These condensed vapors are corrosive and can react with other collected materials to form explosive perchloric salts and esters. To minimize the corrosive and reactive effects of these compounds, perchloric acid hoods are built with welded stainless steel hood surfaces, ductwork, and fans and are equipped with a wash down system. This system should be used after each use of heated perchloric acid. Any materials that are deposited within the system are washed away which prevents the buildup of perchlorates. Perchloric hoods must be used if perchloric acid is to be used above ambient temperature or at concentrations above 72%.

(Always use a Perchloric acid hood when heating Perchloric acid.)

- Ductless/Recirculating hood – These hoods filter air through HEPA or charcoal filters and then discharge the filtered air back into the laboratory. They may not be used without approval of Occupational Health & Safety and Environmental Management.
3.5.1.2 Fume Hood Safety and Guidelines

While the chemical fume hood is a very effective engineering control, it does not provide absolute containment or protection. This is true in respect to materials with very low exposure limits in the low parts per billion range. However, adequate protection can be provided by an efficiently working hood in a properly ventilated room. Certain work practices are required for the hood to have this efficiency. The following work practices are required at a minimum. More stringent practices may be necessary in some circumstances.

- Wear appropriate personal protective equipment when working with chemicals, even when work is conducted in a fume hood. At a minimum wear eye protection, gloves and lab coat.
- The recommended working heights are most commonly between 12 and 18 inches depending on the procedure. Contact your principal investigator for the recommended working height of the particular hood. Always mark the hoods showing where the sash must be positioned and the measured face velocity.
- It is suggested that the hood sash be lowered or closed when not in use. As a general rule, the hood should not be used with the sash fully open.
• All chemical hoods at Stephen F. Austin State University should have face velocities between 80-120 feet per minute with the sash at the recommended working height.
• Any and all operations & experiments that generate air contaminants above the exposure limit must be conducted inside a hood.

GOOD
(This person is using the fume hood at the certified or marked working height. They are also wearing gloves, safety glasses and their lab coat as additional protection against spills, splatters and explosions.)

BAD
(This person is not using the fume hood at the certified or marked working height. They are not wearing any personal protective equipment which is even more important when someone is not using the fume hood correctly.)

• Do not position air vents or fans so as to direct airflow across the face of the hood.
• All apparatus should be a minimum of 6 inches back from the face of the hood.
• Do not put your head in the hood when contaminants are being generated.
• Fume hoods are not to be used as a waste disposal mechanism except for very small quantities of volatile materials.
• Do not store excessive amounts of chemicals or apparatus in the hood. This can greatly impair its performance.
Fume hoods cannot be used for storage

- Be sure that the hood is on when in use. (A simple way to make sure that the hood is pulling in air is to tape a wipe or paper to the bottom of the sash. If it is not pulled back towards the inside of the hood, it may not be on or may be broken and need to be checked EHS&RM.

- Fume hoods may not adequately contain hazardous solids in powder form. Please contact your principal investigator or EHS&RM.

- The slots of the baffles along the back of the hood should be kept free of obstruction. No more than 25% of the bottom slot should be blocked.
• Foot traffic past the hood should be kept to a minimum when in use.
• Laboratory doors and windows should be kept closed. (Except when the lab is designed for them to be open)
• Do not remove the hoods sash or panels except when it is necessary to set-up apparatus. They must be replaced before any operations begin.
• Do not place any spark source (i.e. electrical receptacles) inside the hood when flammable gases or liquids are present.
• Permanent electrical receptacles are not permitted in the hood.
• If there is a chance of explosion or eruption, use an appropriate barricade or shield.

• All chemical hoods should have spill protection lips along the front of the hood. If your hood has a cup sink, it should have a lip as well.
• If the hood sash is supposed to be partially closed for operation, the hood should be labeled as so. The appropriate closure point should be clearly indicated.
• It is suggested that all large equipment be elevated 1-2 inches above the working surface of the hood. This reduces the amount of baffle blockage and maintains the hoods performance.
• If perchloric acid will need to be heated above ambient temperatures or is used at a concentration above 72%, one must use a specifically designed hood for this process. (Please refer to the definition of perchloric acid hoods in the previous section if this rule applies to you)
3.5.1.3 Certification of Fume Hoods

Annually, the Department of Environmental Health, Safety & Risk Management measures the face velocity of every chemical fume hood on the campus of Stephen F. Austin State University. Physical Plant Department is notified when repairs are needed to restore any marginal or failing hood to a passing range or to fix any monitor or general issues associated with the hood. Once repairs have been made, EHS&RM is notified by Physical Plant and the hood is rechecked and recertified if passing. If you work in a lab with a chemical fume hood and notice a problem with the air flow, monitor, or general function of the hood, please contact EHS&RM at 468-6034.

3.5.2 Personal Protective Equipment

The most important thing to remember about personal protective gear 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 equipment required for the particular work you are performing. The principal investigator and laboratory safety officer are primarily responsible to ensure that all workers and personnel are using the appropriate personal protective equipment.

3.5.2.1 Protective Clothing

- The lab coat is designed to protect the clothing and skin from chemicals that may be spilled or splashed. It should always be properly fitted to the wearer and is best if it is knee length. There are several types of lab coats for different types of protection.
  - Cotton protects against flying objects, sharp or rough edges and is usually treated with a fire retardant. Since many synthetic fabrics can adhere to skin when burning, and thereby increase the severity of a burn, cotton is the most preferred laboratory clothing fabric.
  - Wool protects against splashes of molten materials, small quantities of acid and small flames.
  - Synthetic fibers protect against sparks and infrared or ultraviolet radiation. However, synthetic fiber lab coats can increase the severity of some laboratory hazards. For instance, some solvents may dissolve particular classes of synthetic fibers, thereby diminishing the protective ability of the coat. In addition, on contact with flames, some synthetic fibers will melt. The molten material can cause painful skin burns and release irritating fumes.
  - Aluminized and reflective clothing protect against radiant heat.

- An apron provides an alternative to the lab coat. It is usually made of plastic or rubber to protect the wearer against corrosive or irritating chemicals. An apron should be worn over garments that cover the arms and body, such as a lab coat.
- Loose or torn clothing can fall into chemicals or become ensnared in equipment and moving machinery. Aprons, lab coats and other protective clothing should be readily available and utilized in a laboratory environment.
• If necessary, hair should also be restrained because loose hair can catch fire or dip into chemical solutions.

**Foot Protection**

Foot protection is essential to prevent injury from corrosive chemicals, heavy objects, electrical shock, as well as giving traction on wet floors. If a corrosive chemicals or heavy object were to fall on the floor, the most vulnerable portion of the body would be feet. For this reason, shoes that completely cover and protect the foot are recommended.

Though it is practically impossible to provide foot safety gear to everyone working in the laboratories, the following shoe types should never be worn in the laboratory:

a) Sandals
b) Clogs
c) High Heels
d) Shoes that expose the foot in any way

**3.5.2.2 Protective Gloves**

• 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. Glove manufacturers and the Material Safety Data Sheets accompanying products in use are good sources of specific glove selection information, or contact EHS&RM for assistance in selection. Below is some helpful information regarding glove suitability?

a) Latex “surgeons” or “exam” gloves are a general use laboratory glove and provide minimal chemical resistance and light protection against irritants and limitant protection against infectious agents.
b) PVC protects against mild corrosive and irritants.
c) Natural rubber gloves protect against mild corrosive material and electric shock.
d) Neoprene gloves are suitable for working with solvents, oils, or mild corrosive material. Butyl, Neoprene and nitrile gloves are resistant to most chemicals, e.g., alcohols, aldehydes, ketones, most inorganic acids, and most caustics.
e) Cotton gloves absorb perspiration, keep objects clean and provide some limited fire retardant properties.
f) Zetex gloves resist abrasion, most acids (except hydrofluoric acid), alkalis and solvents.

• 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 spread of contamination.
• Check gloves for cracks, tears, and holes.
• Care should be taken when removing gloves. Peel the glove off the hand, starting at the wrist and working toward the fingers. Keep the working surface of the glove from
contacting skin during removal. Contaminated disposable gloves should be discarded in designated containers (e.g., biohazard waste containers).

- Always wash hands as soon as possible after removing protective gloves.

### 3.5.2.3 Eye and Face Protection

Laboratory work may require eye and face protection to reduce the possibility of chemical exposures due to splashes. Eye protection is required of everyone who enters a chemical work area. The type of eye protection needed depends on the circumstances. Typically, safety goggles that protect the top, bottom, front and sides of the eyes is mandatory. Safety goggles should not be worn in conjunction with contact lenses, except for therapeutic reasons. If contact lenses are worn the Laboratory Coordinator or Principal Investigator and co-workers should all be aware of this, in case an accidental splash renders the wearer of such lenses incapable of washing or rinsing his or her eyes.

Face shields are necessary when working with severely corrosive liquids, with glassware under reduced or elevated pressure, with glass apparatus used in combustion or other high-temperature operations, and when there is a possibility of an explosion or implosion.

### 3.5.2.4 Respirators

The laboratory equipment respirators may sometimes be relied on if the engineering controls and laboratory design do not adequately limit the potential exposure to hazardous air contaminants. Individuals planning to use respiratory protection should contact EHS&RM for consultation. The proper selection and type of respirator used should be based on a thorough analysis of the specific activity planned. The EHS&RM department will assist the respirator user in evaluating their individual circumstances. In addition all individuals who wear respirators, other than dust mask as a personal preference, must first be medically approved by a occupational health physician and then should be fit tested by the department of EHS&RM.
3.5.3 Eye Wash Stations and Safety Showers

3.5.3.1 Safety Showers:

Each laboratory area should be equipped with a safety shower. The ANSI standard, Z358.1-1980, emergency eyewash and shower equipment, requires that emergency showers be located no more than 10 seconds in time or greater than 100 feet from the hazard. The shower must be readily accessible, be kept clear of obstructions, and clearly labeled. The valve must open readily and remain open until intentionally closed. Although and associated floor drain is desirable, its absence should not prohibit installation of a safety shower. The above mentioned standards apply to all emergency showers including eye and face wash stations. The departments of Environmental Health, Safety & Risk Management together with the Laboratory supervisor are responsible for inspecting the safety showers on a regular schedule.

- The water column must be between 82 and 92 inches with a minimum of 20 inches diameter of column and 60 inches above the surface.
- Water delivered must be a minimum of 20 gallons per minute.
- If an enclosure is used there must be an unobstructed minimum diameter of 34 inches.
- Must me identified with a highly visible sign located in a well lit area.

3.5.3.2 Eye/Face Wash Stations:

- Eye wash stations are designed to provide a gentle and continuous, low pressure flow of tempered aerated potable water at 0.4 gallons per minute for a period of atleast 15 minutes.
- All employees and students must be familiar with the location and use of eye wash and safety showers even if their job does not involve working directly with toxic or corrosive chemicals.
- The distance from the location of the employee and eye wash station should not exceed 10 seconds walking distance or greater than 100 feet from the hazard.
- The path to the eye wash or face wash station should be unobstructed.
- The path to the eye wash or safety shower cannot involve opening a door unless:
  a. There is always another employee present that can open the door.
  b. The exposed employee can exit the room without having to manually manipulate a door knob (i.e. push bar)
- The location of all eye washes and safety showers must be clearly marked with a highly visible sign. The area around the shower must be well lit.
- The temperature of the water delivered should be between 60°F and 95°F.
- Plumbed units should be activated once a week to flush lines. Self contained units should be activated in accordance with the manufacturer’s directions.
3.5.3.3 Emergencies Procedures for Eye Wash

- Hold eyelids open using the thumb and index finger to help ensure that effective rinsing has occurred behind the eyelid. It is normal to close the eyes tightly when splashed, but this will prevent water or eye solution from rinsing and washing the chemical out. Eyelids must be held open.
- Necessary training or practice of this procedure to respective personnel is encouraged to help familiarize potential users with the feel of rinsing. It will also make it easier for the user to react both promptly and properly to an emergency situation.
- Always wash from the outside edges of the eyes to the inside; this will help to avoid washing the chemicals back into the eyes or into an unaffected eye.
- Water or eye solution should not be directly aimed onto the eyeball, but aimed at the base of the nose.
- Velocity of the stream of water must be such that injury to the eye is avoided.
- Flush eyes and eyelids with water or eye solution for a minimum of 15 minutes. “Roll” eyes around to ensure full rinsing.
- Contact lenses must be removed as soon as possible to ensure that chemicals are not trapped behind the lenses and then the eyes can be completely rinsed of any harmful chemicals.
- Medical attention should be sought immediately. Ideally another person in the lab should make contact with responders or dial 911. The sooner medical attention can be given, the chances of not sustaining permanent damage or blindness is greatly improved.
3.6 Housekeeping

- Maintaining a lab in a clean and orderly manner is critical to the safety of the working environment.
- Clutter leads to accidents and the easier start and spread of fires.
- Keep drawers and cabinet doors closed and electrical cords off the floor to avoid tripping hazards.
- Keep aisles clear of obstacles such as boxes, chemical containers, and other storage items that might be put there.
- Avoid slipping hazards by cleaning up spilled liquids promptly and by keeping the floor free of loose equipment such as stirring rods, glass beads, stoppers, and other such hazards.
- Never block or even partially block the path to an exit or to safety equipment, such as a safety shower or fire extinguishers.
- Use the required procedure for the proper disposal of chemical wastes and solvents.
- Supplies and laboratory equipment on shelves should have sufficient clearance so that, in case of a fire, the fire sprinkler heads are able to carry out their function.
- The work area should be kept clean and uncluttered, with hazardous materials and equipment properly stored.
- Clean the work area upon completion of a task and at the end of the day. The custodial staff is only expected to perform routine duties such as cleaning the floor and emptying the general trash.
- In preparation for any maintenance service such as, fume hood repair, plumbing, electrical etc. the laboratory staff must prepare the laboratory before the maintenance personnel arrive. Whenever possible remove hazards that maintenance personnel may encounter during their work activities. For example, infectious agents, radioactive materials or chemicals must be moved to a secure area prior to initiation of maintenance work. Additionally, the Principal Investigator or Laboratory Coordinator must escort Plant Operations personnel into the laboratory and inform them of the presence of any hazardous materials prior to the work being done.
- For the safety of the lab and maintenance personnel, the department of EHS&RM recommends that maintenance personnel be supervised at all times while in the laboratory.
3.7 Eating, Drinking, and Smoking

*Eating, drinking, smoking, gum chewing, applying cosmetics, and taking medicine in laboratories is strictly prohibited.*

- Food, beverages, cups and other drinking and eating utensils should not be stored in areas where hazardous materials are handled or stored.
- Glassware used for laboratory operations should never be used to prepare or consume food or beverages.
- Laboratory refrigerators, ice chests, cold room, ovens, and so forth should not be used for food storage or preparation.
- Refrigerators used for the provision of food storage must be marked “For Food Storage Only.”
- Laboratory water sources and deionized water should not be used for drinking water.
- Laboratory materials should never be consumed or tasted.

3.8 Electrical

- 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.
- Properly ground all electrical equipment.
- 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.
- 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.
- Do not run electrical cords above the ceiling. The cored must be visible at all times to ensure it is in good condition.
- 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.
- Do not use extension cords for permanent wiring. If you must use extension cords throughout the laboratory, then it is time to have additional outlets installed.
3.9 Fire Safety Equipment

3.9.1 Fire Extinguishers

Fire extinguishers are very important components of laboratory safety. Fire extinguishers are spaced and located as required by current fire codes and standards. Currently the department of Environmental Health, Safety and Risk Management performs monthly inspection and performs required maintenance on all fire extinguishers at Stephen F. Austin State University.

- Only use a fire extinguisher if the fire is very small and you know how to use the extinguisher safely. If you can’t put out the fire, leave immediately. Make sure you call 911 or fire department even if you think the fire is out.
- In laboratories, fire extinguishers should be securely located on the wall near an exit. The lab occupant should be aware of the condition of the fire extinguishers by observing them for broken seals, damages, low gauge pressure, or improper mounting.
- Occupants of laboratories should visually inspect lab fire extinguishers at least monthly. Units that are missing, have broken seals, low pressure or visible damage should be reported to EHS&RM immediately for replacement.
- For fire extinguisher service, requests, training, or any questions call EHS&RM at 468-4532.

3.9.2 Fire Alarms

Fire alarms are designed so that all endangered laboratory personnel and building occupants are alerted by an audible warning (in many buildings there is also visual warning).

- All employees/students should become familiar with the exact location of the fire alarm pull stations nearest to their laboratory.
- Sprinkler systems, smoke detectors and heat detectors may automatically activate the fire alarm. (This should not be considered a substitute for manual fire alarm activation.)
- Smoke detectors should never be tampered with and must be regularly checked for viable battery.
- In case of a fire, immediately exit the building and call 911 or Campus Police.

3.9.3 Sprinklers

Sprinklers are designed to enhance life safety by controlling a fire until the fire department arrives or, in many cases, completely extinguish the fire.

- Sprinklers are automatically activated, and laboratory workers should not attempt to shut off or tamper with the system.
- Items in the laboratory must be stored at least 18 inches below the sprinklers.
- Items (e.g., wiring or tubing etc.) must not hang from the sprinklers or sprinkler pipes.
- Sprinklers must not be painted or otherwise obstructed.
- Intense heat should not be used near sprinklers.
3.9.4 Fire Blankets

Fire blankets, for example, can provide you with extra support when you're faced with a fire situation. When you smother the flames with a fire blanket, you are extinguishing the fire because you are taking away the oxygen. When the blanket covers the fire, it pushes the oxygen away from the fire source, causing the fire to grow smaller and smaller until all of the oxygen has been removed and the fire it completely out.

Fire blankets should be checked in the same way as fire extinguishers. A test label will normally be fixed to the back of the fire blanket and the test date recorded. It is recommended that you check that the blanket has been inspected within the last year as part of your safety inspections. You should also check that a fire blanket notice is placed near the blanket. This notice gives basic guidance on how to use the blanket in an emergency. If the blanket has not been tested or is missing a notice, please report this to EHS&RM at 468-6034.
4. Emergency Procedures

4.1 First Aid

In any event first call 911 and Campus Police. You can also use campus phones to dial 911 and reach campus police.

4.1.1 First Aid Kits

First aid kits should be standard equipment in every laboratory. Commercial, cabinet-type, or unit-type first aid kits are acceptable. A typical first aid kit for laboratories includes a variety of items specially selected to carry out emergency treatment of cuts, burns, eye injuries, or sudden illness. The first aid kit should contain individually sealed packages for each type of item. Contents of the kit should be checked weekly to ensure that expended items are replaced. Laboratory supervisors are responsible for maintaining the contents of the first aid kit. For assistance in locating a supplier call EHS&RM at 468-6034

4.1.2 Wounds

Small cuts and scratches

- Direct pressure -- place sterile pad over wound and apply pressure evenly with the opposite hand.
- Elevation -- if direct pressure does not control bleeding, raise the area above the level of the heart.
- Cleanse area with soap and water.

Significant bleeding

- Call 911.
- Direct Pressure -- place sterile pad over wound and apply pressure evenly with the opposite hand.
- Elevation -- if direct pressure does not control bleeding raise the area above the level of the heart.

4.1.3 Thermal Burns

First degree burns (e.g., sunburn or mild steam burn) are characterized by redness or discoloration of the skin, mild swelling and pain.

- First Aid procedures for first degree burns are as follows:
  - Apply cold water applications and/or immerse in cold water for at least 10 minutes.
Seek further medical treatment as needed.

*Second and third degree burns* are characterized by red or mottled skin with blisters (second degree), white or charred skin (third degree).

- First aid procedures for second and third degree burns are as follows:
  - Call 911.

### 4.1.4 Chemical Burns

If hazardous chemicals should come into contact with the skin or eyes, follow the first aid procedures below.

- **Skin:**
  - Remove victim's clothes -- don't let modesty stand in the way.
  - Remove victim's shoes -- chemicals may also collect here.
  - Rinse the area with large quantities of water for at least 15 minutes (sink, shower, or hose).
  - Do Not apply burn ointments/spray to affected areas.
  - Call Emergency Rescue (911) without delay.

- **Eyes:** (acid/alkali, e.g., HCl, NaOH)
  - Call 911 without delay and follow the instructions given in eye wash station.

### 4.1.5 Ingestion of Chemicals

- Call 911 Immediately.
- Call the University Health Center for advice on appropriate actions to be taken while awaiting emergency medical assistance.
- If the victim is unconscious, turn their head or entire body onto their left side. Be prepared to start CPR if you are properly trained, but be cautious about exposing yourself to chemical poisoning via mouth-to-mouth resuscitation. If available, use a mouth to mouth resuscitator.
4.1.6 Inhalation of Chemicals

- Evacuate the area and move the victim into fresh air.
- Call 911 without delay.
- If the victim is not breathing and you are properly trained, perform CPR until the rescue squad arrives. Be careful to avoid exposure to chemical poisoning via mouth-to-mouth resuscitation. Use a mouth-to-mask resuscitator.
- Treat for chemical burns of the eyes and skin as noted above
4.2 Chemical Spills

4.2.1 Spill Response and Clean-up Procedures

In the event of a chemical spill, the individual who caused the spill is responsible for prompt and proper clean up. It is also their responsibility to have spill control and personal protective equipment appropriate for the chemicals being handled readily available. See Developing a Spill Response Plan for more information.

The following are general guidelines to be followed for a chemical spill. More detailed procedures may be available with your laboratory spill response plan or lab supervisor or principal investigator.

1. Immediately alert area occupants and supervisor, and evacuate the area, if necessary.
2. If there is a fire or medical attention is needed, immediately contact 911.
3. Attend to any people who may be contaminated. Contaminated clothing must be removed immediately and the skin flushed with water for no less than fifteen minutes. Clothing must be laundered before reuse. See first aid for more information.
4. If a volatile, flammable material is spilled, immediately warn everyone, control sources of ignition and ventilate the area.
5. Don personal protective equipment, as appropriate to the hazards. Refer to the Material Safety Data Sheet or other references for information.
6. Consider the need for respiratory protection. The use of a respirator or self-contained breathing apparatus requires specialized training and medical surveillance. Never enter a contaminated atmosphere without protection or use a respirator without training. If respiratory protection is needed and no trained personnel are available, call EHS&RM at 468-6034. If respiratory protection is used, be sure there is another person outside the spill area in communication, in case of an emergency. If no one is available, contact 911 or EHS&RM.
7. Using the chart below, determine the extent and type of spill. If the spill is large, if there has been a release to the environment or if there is no one knowledgeable about spill clean-up available, contact EHS&RM at 468-6034 or 911.

<table>
<thead>
<tr>
<th>Category</th>
<th>Size</th>
<th>Response</th>
<th>Treatment Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>up to 300cc</td>
<td>chemical treatment or absorption</td>
<td>Neutralization or absorption spill kit</td>
</tr>
<tr>
<td>Medium</td>
<td>300 cc - 5 liters</td>
<td>absorption</td>
<td>Absorption spill kit</td>
</tr>
<tr>
<td>Large</td>
<td>more than 5 liters</td>
<td>call EHS&amp;RM</td>
<td>outside help</td>
</tr>
</tbody>
</table>

8. Irrespective of the size of the spill notify EHS&RM.
9. Protect floor drains or other means for environmental release. Spill socks and absorbents may be placed around drains, as needed.
10. Contain and clean up the spill according to the table above. Loose spill control materials should be distributed over the entire spill area, working from the outside, circling to the inside. This reduces the chance of splash or spread of the spilled chemical. Bulk absorbents and many spill pillows do not work with hydrofluoric acid. POWERSORB (by 3M) products and their equivalent will handle hydrofluoric acid. Specialized hydrofluoric acid kits also are available. Many neutralizers for acids or bases have a color change indicator to show when neutralization is complete.

11. When spilled materials have been absorbed, use brush and scoop to place materials in an appropriate container. Polyethylene bags may be used for small spills. Five gallon pails or 20 gallon drums with polyethylene liners may be appropriate for larger quantities.

12. Complete a hazardous waste sticker, identifying the material as Spill Debris involving XYZ Chemical, and affix onto the container. Spill control materials will probably need to be disposed of as hazardous waste. Contact EHS&RM at 468-6034 for advice on storage and packaging for disposal.

13. Decontaminate the surface where the spill occurred using a mild detergent and water, when appropriate.

14. Report all spills to your supervisor or the Principal Investigator.

4.2.2 Developing a Spill Response Plan

An effective spill response procedure should consider all of the items listed below. The complexity and detail of the plan will, of course depend upon the physical characteristics and volume of materials being handled, their potential toxicity, and the potential for releases to the environment.

1. Review Material Safety Data Sheets (MSDSs) or other references for recommended spill cleanup methods and materials, and the need for personal protective equipment (e.g., respirator, gloves, protective clothing, etc.)

2. Acquire sufficient quantities and types of appropriate spill control materials to contain any spills that can be reasonably anticipated. The need for equipment to disperse, collect and contain spill control materials (e.g., brushes, scoops, sealable containers, etc.) should also be reviewed. See recommended spill control materials inventory for more details. EHS&RM maintains few spill control kits that can be used if no other materials are available.

3. Acquire recommended personal protective equipment and training in its proper use. For example, if an air purifying respirator or self-contained breathing apparatus are needed, personnel must be enrolled in the Respiratory Protection Program and attend annual training and fit-testing.

4. Place spill control materials and protective equipment in a readily accessible location within or immediately adjacent to the laboratory.

5. Develop a spill response plan that includes:
   - Names and telephone numbers of individuals to be contacted in the event of a spill.
   - Evacuation plans for the room or building, as appropriate.
   - Instructions for containing the spilled material, including potential releases to the environment (e.g., protect floor drains).
6. Discuss the spill response plans with all employees in the area.

4.2.3 Recommended Spill Control Material Inventory

Your laboratory or work area should have access to sufficient quantity of absorbents or other types of materials to control any spill that can be reasonably anticipated.

**Personal Protective Equipment**

- 2 pairs chemical splash goggles
- 2 pairs of gloves (recommend Silver Shield or 4H)
- 2 pairs of shoe covers
- 2 plastic or Tyvek aprons and/or Tyvek suits

**Absorption Materials**

- 4 3M POWERSORB spill pillows (or equivalent)
- 1 3M POWERSORB spill sock
- 2 DOT pails (5 gallon) with polyethylene liners
  - 1 filled with loose absorbent, such as vermiculite or clay
  - 1 with minimum amount of loose absorbent in the bottom

**Neutralizing Materials**

- Acid Neutralizer
- Caustic Neutralizer
  - commercial neutralizers, such as Neutrasorb (for acids) and Neutracit-2 (for bases) have built in color change to indicate complete neutralization
- Solvent Neutralizer
  - commercial solvent neutralizers, such as Solusorb, act to reduce vapors and raise the flashpoint of the mixture

**Mercury Spills**

- Small mercury vacuum to pick up large drops (optional)
- Hg Absorb Sponges - amalgamate mercury residue
- Hg Absorb Powder - amalgamates mercury
- Hg Vapor Absorbent - reduces concentration of vapor in hard to reach areas
- Mercury Indicator - powder identifies presence of mercury
Clean-up Tools

- Polypropylene scoop or dust pan
- Broom or brush with polypropylene bristles
- 2 polypropylene bags
- Sealing tape
- pH test papers
- Waste stickers
- Floor sign - DANGER Chemical Spill - Keep Away
5. Training

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. 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.
- The OSHA Occupational Exposure to Hazardous Chemicals in Laboratories standard. Refer to hazard communication program on the website of EHS&RM.
- 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.
- Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory.
- 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 has implemented to protect personnel from exposures to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.
- 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, hazardous communication training, laboratory safety training, Hazardous waste management training and Fire Safety training are offered by the EHS&RM and are required for graduate students, staff, and faculty that engage in laboratory activities.
5.1 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. EHS&RM department 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.

5.2 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. The department of EHS&RM 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
- Laboratory waste disposal.

5.3 Fire Extinguisher Training

Fire extinguisher training, with live fire suppression, is advised for all laboratory workers. Since live fire drills are not common on campus it is advisable to attend one whenever the department of EHS&RM conducts it. Generally fire extinguisher 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 and 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.
5.4 Hazardous 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 from their laboratory or project to attend this training. 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. EHS&RM 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.

For further information on hazardous waste, please refer to the Hazardous Waste Program Manual on the website of EHS&RM.
6. Inspections

The department of Environmental Health, Safety and Risk Management inspects all laboratories of Stephen F. Austin State University 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 EHS&RM upon completion. If a lab is not in compliance with the safe operating procedures as outlined in this manual, EHS&RM has the authority to close the lab until violations are corrected.

All laboratory personnel 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.
7. Miscellaneous

7.1 Surplus

- Chemicals stored in excess or quantities more than required by the user can be distributed among other laboratories that are in need of the same chemical. Contact EHS&RM at 468-6034 for assistance.
- Lab or medical equipment must not be disposed of in a dumpster but rather via Surplus Property. Environmental Health & Safety must be consulted prior to sending any equipment that contained or could contain hazardous materials to Surplus Property. Keep in mind that many items not immediately suspect for hazardous materials may nonetheless contain metals (mercury columns, tin or lead solder, insulators, springs, etc.) or other hazardous materials.
- Equipment must be visually examined by the user or other knowledgeable individuals for evidence of spills, leaks, damage, or other conditions of concern. All equipment must be cleaned by the user prior to pickup for surplus. Disconnect the equipment from power supplies prior to cleaning and be careful not to combine incompatible substances during cleaning.
- Equipment must be free of bio-hazardous, hazardous, or radioactive materials or residues. If these materials were stored or used in the equipment, contact EHS&RM for assistance with cleaning guidelines and after cleaning so that the item in question may be examined prior to delivery to Surplus Property.
- Oils must be removed from pumps, capacitors, power supplies, or other oil-filled equipment.
- Equipment such as refrigerators or centrifuges that could potentially contain biological hazards (i.e. traces of bacteria, viruses, or human substances) should be cleared to move by the Biological Safety Committee.
- Refrigerants may need to be recovered from freezers, refrigerators, and/or air conditioners by a certified technician prior to pickup by Surplus Property. Contact the Physical Plant Division for more information.

7.2 Defrosting Research Freezer

1. Plan for 2 days of freezer downtime during this process.
2. Never move a freezer to a non-research space (e.g., balcony, corridor, office, etc.) for defrosting.
3. Before thawing, identify hazardous materials stored in the freezer.
   - Wipe down the unit if hazardous chemical contamination is suspected or visible contamination is present.
   - If the freezer has been used to store bio-hazardous material, collect the ice and add 1 part bleach to 9 parts melted ice. Allow 20 minutes of contact time before pouring the melted ice down the drain (preferably in a fume hood).
4. Remove the contents of the freezer. Evaluate what to save and what to eliminate.
5. Unplug the freezer in the morning. This allows you to monitor runoff throughout the day.
6. Never use sharp objects to chip at the ice. Freezer walls are easily punctured by sharp objects, allowing coolant to escape and resulting in expensive repairs or replacement costs.
7. Never allow liquid to run directly onto floors creating a slip hazard, or down any outside drain (a potential regulatory violation).
8. Establish a wick and reservoir system to manage the melting ice: Place a piece of bench paper (paper side down, plastic side up) inside the freezer, on the lower level and lead it into a large autoclave pan. Surround the freezer and autoclave pan with paper towels or bench paper. Manage contaminated ice and liquid according to instructions in step 3.
9. Clean the freezer inside and out with a 10% bleach solution (required if the unit was used for biohazard storage). Clean dirt and dust off the exterior coils, if you can access them, to extend the life of the freezer and save energy.
10. Plug in the freezer and wait for the desired temperature to be reached.
APPENDIX I

LABORATORY SIGNAGE

IN CASE OF EMERGENCY CALL 911

Room Number_________           Department__________________________________________
Laboratory Supervisor/Principal Investigator   ________________________________

Emergency Contacts for laboratory:

<table>
<thead>
<tr>
<th>Name</th>
<th>Office Location</th>
<th>Office Phone</th>
<th>Home Phone</th>
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Special Hazards/Instructions:

_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

Prepared by: _______________________________ Date Posted: __________________

Note: The information in this sign must be updated at least every six months and immediately in the event of any change of emergency contacts or special hazards.
APPENDIX II

Department: __________________________            Building: ___________________________
Room: ________                                                               Lab Name: __________________________
Date: ____________                                                         Supervisor: __________________________

LABORATORY INSPECTION CHECKLIST

Hazard Communication Act:

☐ Is there Placarding in the labs regarding safety symbols, PPE, storage precautions and hazards? Example: Warning labels near proper equipment.

☐ Is the chemical storage map prepared and posted in the lab? (details in lab manual)

☐ Is there a “Right to Know” poster installed?

☐ Is there an Emergency contact Information poster installed?

☐ Do you have controlled items/substance analogue?

☐ If yes, do you maintain an updated and annually inspected list?

☐ Do you have any chemicals of interest in the lab? If yes, please provide the list.

☐ Are emergency exits to the lab clearly marked and accessible?

☐ Does the lab maintain written procedures for SWP: safe work procedures and Lab safety manual?

☐ Is Personal Protective clothing and Equipment provided when needed?

☐ Are updated MSDS available and accessible?

☐ Is an Updated chemical Inventory available?

☐ Is the University laboratory safety manual available and posted in a specific location?

☐ Have all the employees and personnel including Teaching, Research and Graduate assistants completed the safety training provided by EHSRM department?

☐ Is any Job specific safety training held for employees on a regular basis?

☐ Are all personnel and students familiar with emergency evacuation plan?

☐ Are their safety training records available?
Chemical Storage:

☐ Are all chemicals stored by hazard class, eg: Flammables, oxidizers, acids, bases, reactives and toxins?
☐ Are chemicals stored together according to compatibility?
☐ Are correct containers being used to store substances?
☐ Are there any chemicals being stored in cracked glassware?
☐ Are all the containers labeled properly? (All containers include secondary containers for secondary containment and any falling labels should be taped or a new label should be attached)
☐ Are flammables and corrosives stored in approved cabinets?
☐ Are flammables and corrosives stored separately?
☐ Are there any breakable chemical containers stored on the floor?
☐ Are the containers closed at all times?

☐ Do shelves holding chemicals have a lip?
☐ Are hazardous substances stored properly?
☐ Are any of them stored above eye level?
☐ Are all the chemicals dated when received and opened?
☐ Are peroxide forming chemicals (eg: ethers) dated upon receipt and disposed of within the prescribed time period? (Peroxides can be explosively unstable)
☐ Check for expiration dates on unstable chemicals? Examples: Dioxane, Ethers, Furans, Picric Acid, Perchloric acid, Sodium Amide etc...
☐ Are Ether and other highly flammable materials stored away from sources of heat and ignition?
☐ Are acids stored separately in a acid cabinet or secondary containment area?
☐ Is Nitric acid stored separately from other acids?
☐ Is the lab stored with excessive amount of chemicals?
Are there bunding or spill trays for storage of liquids?

Are refrigerators suitably labeled? ( No food, no drink)

Is there any food stored in the refrigerators along with chemicals?

Are there any flammables in household type refrigerators?

Are gas cylinders present?

What type of Gas?

Are they listed in the chemical inventory?

Are they chained?

**Chemical Fume Hoods:**

Are fume hoods tested annually?

Are they placed greater than 5 feet from exits?

Are they kept clear when no experiments are being conducted?

Are ‘experiments in progress’ labeled and procedures outlined for emergency preparedness when appropriate?

Are chemicals evaporated in Hoods? If so what chemicals?

Are lab personnel instructed not to dispose of chemicals by fume hood evaporation? By law, waste containers must be capped.

**Waste Disposal:**

Are appropriate waste disposal containers being used?

Is the illegal disposal of hazardous substances down the drain prevented?

Is there a designated and labeled waste storage area?

Is waste segregated properly?

Is liquid waste stored in screw top containers?
Are the containers closed at all times?

Are there any leaking containers?

Is there any acutely hazardous waste more than one quart present? (acute hazardous waste list is provided in the lab manual)

Less than a total of 55 gallons of possibly hazardous waste is present?

Are waste labeled according to their characteristic and nature?

Are all constituents in mixtures identified, as well as their concentrations? (to be mentioned in the labels)

Are people aware of hazardous waste disposal procedures: location of waste, dates of collection, labeling and logging procedures, segregation and placement of different kinds of waste?

Is a glass bin being used?

Is a sharps bin being used?

Are there any unmarked waste containers?

Do you have waste tags supplied by the EHSRM department?

Do the completely filled waste containers have a properly filled out waste tag?

**Emergency Equipment:**

Is a First kit available and accessible?

Is it serviced regularly?

Are there any designated First Aid personnel identified for the lab?

Are appropriate spill kits available?

Is there a sprinkler system for the lab?

Is a fire blanket available and accessible?

Is the Fire extinguisher accessible with instructions in tact?

Is the safety shower accessible?

Is it tested regularly?

Is the eye wash hose accessible and tested regularly?
**Housekeeping: Floor, Electrical, Lighting & Ventilation:**

- Is the floor kept clean, dry and free from slip & trip hazards?
- Are tops of the shelves and cabinets free from stored items?
- Is the lab cleaned regularly?
- Are the bench tops and sink areas clean and tidy?
- Is there any Dangerous clutter on floor?
- Are the walkways clear of any obstructions?
- Is there adequate lighting and cross room ventilation?
- All electric cords are in good condition: None cracked or brittle
- All electric equipment is properly grounded.
- Do you use extension cords as a permanent power source?
- No electrical or extension cords are run above the ceiling or behind walls.
- Are there any extension cords running across the floor where they could be a tripping hazard?
- Is there a step ladder available in the department for out of reach items?
- Are all heavy objects confined to lower shelves?

**Microbiological Waste:**

- Is the waste treated in lab?
- How: Autoclaved or disposed by EHSRM

**Miscellaneous Safety:**

- Is there any evidence of food or drink in the laboratory?
- Are any lab personnel without proper clothing or without closed toe shoes?
- Are any persons talking on cell phones while working?
Radiation Safety:

☐ Are any radioactive substances used?
☐ Are the radioactive areas clearly marked?
☐ Is radioactive waste store separately?
☐ Is absorbent material readily available to contain any spill?
☐ Is adequate and sufficient shielding provided and used?
☐ Is the radioactive material securely stored?
APPENDIX III

Common Laboratory Inspection Violations

1) **Chemical Storage:**
   - Incompatible Chemicals Stored Together
     - Acids/bases
     - Flammables/oxidizers
     - Organic/inorganic Acids
     - Water Reactives/Water or Water-based Compounds
     - Oxidizers Stored on Incompatible Shelf Material
   - Containers not sealed properly.
   - Compromised Containers.
     - Corroded
     - Cracked
     - Leaking
   - Fume Hood utilized for actively storing chemicals.

2) **Compressed Gas Cylinders:**
   - Unsecured.
   - Not secured properly
   - Utilizing regulator as isolation device.
   - Valve caps not on cylinders in storage.

3) **Door Signage:**
   - None
   - Incomplete
   - Outdated/Incorrect Information

4) **Electrical:**
   - Damaged/Frayed Power cords
   - Extension cords utilized for permanent wiring.
   - Use of multiple power strips inline.
   - No strain relief on energized cords.
5) **Eye Wash:**
   - Blocked/Obstructed eye wash.
   - Non compliant eye wash.
   - No eye wash.

6) **Fire Extinguisher:**
   - No fire extinguisher.
   - Fire extinguisher blocked.
   - Fire extinguisher on floor.

7) **Flammable Storage:**
   - Flammables stored in unapproved refrigerator.
   - Open Flammable cabinet.
   - Flammable containers on floor outside cabinet.

8) **Food:**
   - Evidence consistent with eating or drinking in the lab.
   - Food stored in the laboratory.

9) **Fume Hood:**
   - Sash above working height during use.
   - Baffles obstructing.
   - Using hood while failing.
   - Excessive chemicals and equipment in the hood.
   - Used for storing chemicals.
   - Used as waste disposal mechanism for large quantities of chemicals.

10) **Hazardous Waste:**
    - No labels.
    - Incomplete Label: “Hazardous Waste” not on label, No fill date, No contents listed.
    - Open containers of hazardous waste.
    - Evidence of improper disposal.
11) **Housekeeping:**

- Means of egress, i.e., doorways and aisles blocked.
- Chemicals stored in aisle ways - obstructing egress and spill potential.
- Slip/Trip hazards – power and extension cords, liquids on floor.
- Overabundance of combustibles.

12) **Labeling:**

- Chemical containers not labeled.
- Illegible container labels.
- Incomplete labels.
- Food stuffs utilized for research not labeled for intended use, i.e., “food not to be used for human consumption”.

13) **Peroxide Forming Chemicals:**

- Not dated for disposal.
- Not disposed of by manufactures expiry date.

14) **Safety Shower:**

- Blocked/Obstructed.
- Shower activation handle tied back.
- No shower.
- Non Compliant shower

15) **Training and Records:**

- All affected employees not received Laboratory Safety Training and Lab Safety Manual.
- All affected employees not received Laboratory specific training.

16) **Other:**

- No designated Laboratory Safety Officer.
- No chemical inventory or Incomplete Chemical Inventory.
- Incomplete MSDS or No MSDS.