Laboratory Safety Manual

Laboratory Safety Policies and Procedures

Environment, Health and Safety Office
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Scope and Application

Authority & Responsibilities

By authority delegated from the University President, Environment, Health and Safety Office, Campus Safety Committee and Operations Committee are responsible for the safety of all facilities at the University. Under this authority, policies are developed to provide a safe teaching, research, service, housing and recreational environment.

The mission of the Environment, Health and Safety Office is to support and advance the teaching, learning, and research activities of the University through promotion of a safe and healthy campus environment. This is accomplished providing and coordinating programs and services that minimize safety, health, environmental and regulatory risks to the AHU community in a manner consistent with responsible fiscal and environmental stewardship. Inherent in this mission is the charge to provide a safe and healthy environment in which the University's activities can be pursued.

The University adopts all applicable federal and state safety laws, rules and regulations in order to carry out its duties and responsibilities. In addition, Environment, Health and Safety Office will reference standards or codes related to safety, which have been adopted and promulgated by nationally recognized standards-setting organizations. The interpretation of safety codes and standards is the responsibility of the Environment, Health and Safety Office.

In order to assure an effective Safety Program for AHU, it is imperative that all individuals associated with the University comply fully with the policies and procedures set forth in this manual.

Policy Statement

It is the policy of the AHU to provide a safe working and learning environment. The Environment, Health and Safety Office has developed this manual as a guidance document to familiarize AHU faculty, staff, students, volunteers, and visitors with the institution-wide policies and procedures for the safe use of hazardous chemical and other material at the University and its affiliates. When these policies and procedures are followed, the risk of occupational exposures to chemicals and physical hazards as well as the risk of accidental environmental release of hazardous materials is minimized.

The primary responsibility for insuring safe conduct and conditions in the laboratory or research area resides with the laboratory coordinators and principal investigators. The laboratory coordinators and principal investigators should be familiar with the contents of this manual, make sure all his or her workers are familiar with it, and ensure all work with chemical and biological hazardous materials is conducted in compliance with University policies and procedures. This Laboratory Safety Manual (LSM) should be used in conjunction with the Campus Safety Manual, Biosafety Manual, and Hazardous Waste Management Manual, which provides more general safety information. These manuals describe policies and procedures that are required for the safe conduct of teaching, research, and professional services at AHU.

The primary objective of this document is to provide a general guide for working in laboratories. The Laboratory Safety Manual establishes the basic safety principles for laboratory procedures, equipment and work practices. The Laboratory Safety Manual is intended only to address those universal safety measures necessary for achieving a generally safe and healthy work environment. Wherever the scope of hazards is not adequately addressed by this general document, the principal investigator or

laboratory coordinator must develop specific Standard Operating Procedures.

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Contact Information

Emergency Contact Numbers

Fire/Police/Ambulance:	911
(From on-campus phone)	(91-911)
Emergency Security Phone	407-353-4002

Environment, Health & Safety Office
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Office: 407-303-7747 ext. 1103936
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Radiation Safety Officer
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Emergency Management, Fire and Life Safety
Eric Goebelbecker, Campus Security Director
Office: (407) 303-8016
Eric.Goebelbecker@ahu.edu

Vice President for Operations
Ruben Martinez, VP for Operations
Office: (407) 303-1635
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Non-Emergency Office Numbers

VP for Student Services	407-303-8016
Security Coordinator	407-353-4002
Student Housing Office	407-896-5869

Assignment of Responsibility

AdventHealth University (AHU) recognizes the need to use potentially hazardous materials for the purpose of research and teaching. At the same time, the University is committed to ensure the safety of its students, employees, and visitors, and to complying with all regulatory requirements that have an impact on its facilities and operations.

Considering this charge, AHU has designated specific responsibilities for developing and implementing the Laboratory Safety Program. To ensure a successful program, the cooperation of various entities on campus is required. The individuals responsible for maintaining the integrity of the program are listed below, as well as their respective responsibilities.

Environment, Health and Safety Office (EHS)

Coordinator: EHS Coordinator.

The primary purpose of the Environment, Health and Safety Office is to support AHU in its mission of teaching, research and service. Our role to oversee potential safety hazards, to ensure the safety of the campus community and to provide an environment free of unnecessary risks include the following responsibilities:

- Consult with laboratory users regarding the effectiveness of their department's safety efforts.
- Provide training and support for the Environment, Health and Safety Office members, Security officers, departmental chairs, laboratory coordinators, and principal investigators to ensure safety compliance.
- Audit laboratories, evaluate hazards and document laboratory concerns to the Laboratory Coordinators and Principal Investigators. If repetitive deficiencies occur and corrective measures are not implemented in the designated time, the Environment, Health and Safety Office will initiate escalation procedures defined by office members.
- Where necessary, conduct environmental and/or personal monitoring in order to assess the degree of exposure associated with a particular University and laboratory operations.
- Recommend necessary training to University faculty and staff.
- Respond to emergencies as needed.

Environment, Health and Safety Assistant

The EHS Assistant is responsible for:

- Supporting laboratory safety efforts in collaboration with the EHS Coordinator, Biological Safety Officer, and Chemical Hygiene Officer.
- Conducting or assisting in laboratory safety inspections.
- Promotes EHS awareness and fosters this awareness throughout the University.
- Assist staff on occupational health and safety issues.
- Assist the EHS team with the management and disposal of hazardous waste.
- Maintaining, editing, and updating laboratory safety literature.
- Track reported hazards and insufficiencies, including resolutions.
- Collect data, analyze data and create reports, recommendations, and communications.
- Responsible for documentation of Safety Committee meetings.

- Maintaining audit documentation.
- Tracking safety training of personnel.
- Perform field training as needed.
- Assist in permit writing and submission for new construction and renovations.
- Assist with decommissioning laboratories.

Laboratory Health and Safety

Coordinator: Laboratory Safety Officer (LSO)

Laboratory safety officer has responsibility for administering and overseeing institutional implementation of the Laboratory Safety Program. LSO ensures that all EHS Manuals meets relevant OSHA regulatory requirements.

- Conducting periodic inspections and immediately taking steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards;
- Manage and implement the Personal Protective Equipment program
- Performing hazard assessments, upon request; and
- At least annually, reviewing and evaluating the effectiveness of EHS Manuals and making updates when appropriate.

Chemical Health and Safety

Coordinator: Chemical Hygiene Officer (CHO)

The Chemical Hygiene Officer has primary responsibility for ensuring the implementation of 8 CCR 5191, "Occupational Exposure to Hazardous Chemicals in Laboratories." The CHO is a member of EHS and, with support from other EHS personnel, is responsible for:

- Informing PIs/Laboratory Supervisors of chemical-related health and safety requirements and assisting with the selection of appropriate safety controls, including engineering controls, laboratory and other workplace practices and procedures, training, and personal protective equipment;
- Helping to develop and implement appropriate chemical hygiene policies and practices;
- Working with Departments and lab groups to develop and review SOPs for processes using hazardous chemicals;
- Conducting periodic inspections and immediately taking steps to abate hazards that may pose a risk to life or safety upon discovery of such hazards;
- Performing hazard assessments, upon request; and
- At least annually, reviewing and evaluating the effectiveness of EHS Manuals and making updates when appropriate.

Biological Health and Safety

Coordinator: Biological Safety Officer (BSO)

The Biological Safety Officer has the responsibility to oversee an institution-wide biosafety program that will proactively minimize risks to University staff and students due to non-compliance or lack of awareness. As well as implement guidelines established by the Environment, Health and Safety Office, Operations committee, and agencies of the State and Federal government to ensure compliance.

- Develops, implements, and coordinates a comprehensive biological safety program for the University to enhance institutional biosafety related objectives and to ensure compliance with all applicable regulations, guidelines, policies, and directives.
- Coordinates, quality controls, and monitors the delivery of biosafety education and training to any and all AHU faculty, staff, and students who work with or have potential for exposure to biological pathogenic agents.
- Monitors all AHU teaching and research activities involving the use of hazardous biological materials and recombinant DNA molecules for compliance with appropriate regulations, policies, procedures, and best practices.
- Reviews research grant applications, proposals, and activities involving biohazardous materials and recombinant DNA, and approves or recommends modifications to ensure safe practices; provides guidance to researchers and/or performs follow-up as appropriate.
- Oversees select agent transfers to and from University laboratories; monitors use of toxins covered by the CDC's Select Agent ruling.
- Informs and educates staff, students, and other constituencies regarding biosafety issues; develops comprehensive biosafety educational and outreach programs for the University and clinical/research laboratories.
- Oversees the supervision of personnel, which includes work allocation, training, promotion and Enforcement of internal procedures and controls, and problem resolution; evaluates performance and makes recommendations for personnel actions; motivates employees to achieve peak productivity and performance.
- Inspects research and teaching facilities for compliance with regulations and guidelines pertaining to the use, handling, and disposal of potential biohazards and recombinant DNA; coordinates the review and investigation of all biosafety accidents, and develops corrective action plans.
- Develops and implements emergency response procedures for incidents involving biohazardous agents and materials, and maintains AHU Incident Action Plan for biohazards; develops medical surveillance criteria for activities involving biohazards and related materials; responds to biohazardous materials incidents as appropriate.
- Serves as principal source of expertise to the University regarding appropriate equipment, facilities, and work practices for protecting laboratories, staff, and the environment from contamination and infectious organisms.
- Provides technical guidance to faculty and staff in the development of safety plans for grant applications; advises facilities and physical plant staff regarding technical and programmatic issues involving laboratory biosafety design and maintenance.

Radiation Health and Safety

Coordinator: Radiation Safety Officer (RSO)

The Radiation Safety Officer is responsible for preventing or reducing the risk of exposure to students and staff as well as overseeing the Radiation safety program. The Radiation Safety Officer is also responsible for:

- Maintaining compliance with federal and state radiation standards
- Oversight for Radiation waste disposal
- Providing Radiation safety training
- Conducting periodic inspections of equipment and chemical inventory

Emergency Management

Coordinator: Security Director

The Security Director is responsible for maintaining a safe campus environment through the implementation and adherence to emergency preparedness plans. More specifically the Security Director is responsible for:

- Facilitating campus and laboratory emergency response
- Providing medical emergency assistance
- Performing threat assessment and accident investigation
- Tracking incident reports
- Providing emergency safety training
- Reviewing special event and crowd management procedures as needed

Fire and Life Safety

Coordinator: VP Operations

The VP of Operations is responsible for the oversight of Fire and Life safety preparedness plans and maintenance of the systems that are in place to protect the employees, faculty, students, and visitors of AHU. Some of the responsibilities of the VP of Operations include;

- Fire building code plan review
- Establishing fire code inspections and enforcing fixes or improvements
- Fire sprinkler systems maintenance scheduling
- Liaison with local fire departments and emergency first responders

Environmental Protection

Coordinator: VP Operations

The VP of Operations has the responsibility to manage environmental protection efforts. These efforts are performed by the VP of Operations or by others within the Environmental Protection area. The responsibilities include:

- Building code plan review
- Maintaining pest management
- Enforcing electrical safety plans, building hazards plans, evacuation plans, etc.
- Construction project support and compliance
- Encouraging beneficial ergonomics
- Ensuring sanitation compliance
- Managing air emissions compliance
- Scheduling periodic inspections

Campus Safety Committee

The Campus Safety Committee will complete the following responsibilities:

- Support campus safety by working in collaboration with the Environment, Health and Safety Office in supporting the laboratory safety policies and regulations.
- Oversee potential safety hazards and communicate with the Environment, Health and Safety Office.

Operations Committee

The Operations Committee will complete the following responsibilities:

- Support campus safety by working in collaboration with the Environment, Health and Safety Office in supporting the laboratory safety policies and regulations.
- Provide environmental safety policies throughout campus, including classroom, housing, and all the other premises on campus.
- Responsible for supporting the environmental personnel to handle and dispose all the laboratory waste according to the laboratory safety policies and regulations.
- Responsible for the maintenance of fire extinguishers, eye-washes, shower, laboratory furniture (cabinets, countertops), and laboratory infrastructure.

Department Chairs

The Department Chairs will complete the following responsibilities:

- Appoint appropriate individuals to serve as Laboratory Coordinators.
- Ensure that responsible parties comply with the appropriate provisions of all EHS Manuals.
- Responsible for supporting the faculty, Principal Investigators and research staff with all resources necessary to ensure safety compliance.

Laboratory Coordinators

The Laboratory Coordinators will complete the following responsibilities:

- Assume direct responsibility for their laboratory's compliance with all EHS Manuals.
- Develop standard operating procedures (SOPs) for their laboratory.

- Cooperate with the Environment, Health and Safety Office to ensure program compliance.

Principal Investigators

Principal Investigators are teaching faculty performing any activity in a laboratory and individuals classified as PI conducting research at this institution. The Principal Investigators have the following responsibilities:

- Perform safety activities as directed by the Laboratory Coordinators.
- Work with the Environment, Health and Safety Office to identify and address common or general safety concerns.
- Maintain LSM compliance.
- Report any potential hazardous operations to the Laboratory Safety Coordinators promptly.
- Provide to the Laboratory Coordinator a hazard assessment for all procedures.
- Instructing laboratory personnel on potential hazards.
- Correcting work errors and dangerous conditions.
- Encouraging a positive attitude towards safety.
- Selecting the proper personal protective equipment (PPE) and ensuring that it is worn.
- Investigating the circumstances surrounding a laboratory accident and taking steps to avoid recurrence.

Laboratory Employee, Students, and Visitors

- Responsible for their own safety and the safety of their co-workers and visitors around them in the laboratories. All staff, students, and volunteers must demonstrate this responsibility in their actions and attitudes.
- Follow and obey general safety rules and guidelines described in EHS Manuals.
- Read, understand, and follow Standard Operating Procedures for unique laboratory and high hazard operations.
- Report any potentially hazardous operations to the EHS and/or Principal Investigators promptly.

Laboratory Safety Guidelines

Each laboratory at the university is unique, by virtue of the research being performed, the equipment in use, and the physical layout of the lab or utilization of space. Regardless of the characteristics, teaching and research laboratories at the AHU must adhere to the basic safety policies outlined in this manual.

Hazard Awareness

It is the responsibility of the PI and lab staff to strive for a safe working environment in their laboratory. Observed hazards or potential hazards must be identified and corrected immediately.

Hazard Identification

Notice Boards

A notice board posted at all of the entrances to the lab will identify the categories of potentially hazardous materials that may be found in the lab at any given time and contact persons in case of

emergency.

Labeling
The manufacture's label will provide the initial information on the handling of any substance. Directions found on the label must be followed. All bottles and chemical containers must be labeled, including, flasks, beakers, etc. If abbreviations are used, a reference list of the abbreviations must be posted in the lab.

Labeling Secondary Containers
"Secondary Container" is defined as any container being used beyond the original manufacturer's bottle that the chemical was shipped in. This may include, but is not limited to:

- Portable or working containers, such as flasks, beakers or small storage bottles in "immediate" use.
- Storage bottles that are created for distribution of smaller amounts of the chemical to students or colleagues.
- Storage bottles that are created for solutions of the original chemical.
- Sample vials or sealable tubes.

Labeling requirements are regulated by the Occupational Safety and Health Administration (OSHA). The requirements are broken down by type of container as described above.

- Portable or working containers are exempt from the labeling regulations as long as the portable/working container remains in the direct control and supervision of the employee, and only over the duration of a standard working day. For example, you do not need to label a beaker you are using to transfer some acid from a stock bottle to a reaction vessel, or a small storage bottle of ethanol that you are using throughout the day for an experiment. However, once that working "session" is finished, that bottle must be labeled as a secondary storage bottle. The idea is that if a regulator asked you what was in the bottle, you need to be able to respond definitively that you know the chemical's identity and its hazards, but if you were to leave the lab and an emergency responder entered, they could figure out the chemical identity based on the label.
- Storage bottles that are created for distribution of smaller amounts of the chemical are regulated and require at minimum:
  - ✓ the name of the chemical in English (not symbols)
  - ✓ appropriate hazard warnings (any combination of words/pictograms, as long as employees have been trained on pictograms)
  - ✓ specific physical/health hazards, including target organs

Cornell University has an excellent site for printing up your own chemical labels located at http://www.ehs.cornell.edu/labels/rtk_requestlabel.cfm. These labels include precautionary and first aid statements, which makes them only suitable for large bottles, but you can copy and paste the label information into a Word document, and then delete these statements, and edit font size.

- Storage bottles that are created for solutions of the original chemical. These bottles require the same minimum requirements as the storage bottles created for distribution, but
  - ✓ MUST also include concentration of the solution and in what solvent system.
  - ✓ SHOULD include the date the solution was created for future reference.
- Sample vials or sealable tubes. "Batch" labeling can be done where containers are difficult to label because of their size or if labeling with the actual contents is a problem pedagogically

("unknowns" for a teaching laboratory procedure). These containers should be clearly grouped together in a drawer, box or other larger container, and the larger container can be labeled as described previously. Remember that once the container is removed from this labeled area, it must be treated as a portable/working container (under the direct control of the user) or it will be subject to the labeling regulations.

Important Notes about Labeling

- It is very common in academic labs to use symbols and abbreviations to label bottles. In the past, this has been acceptable to OSHA as long as there is a complete list of the translation of any symbols and immediate reference to the hazards associated with the chemical(s). This list must be readily available to employees as well as emergency responders.
- Defacing a manufacturer's label is prohibited. That is to say don't just write over or cover up a manufacturer's label! Scrape it off before re-labeling to avoid any confusion about the contents of the bottle.

Chemical Inventories

A complete inventory of all chemicals at the worksite is required to be maintained at all times. An inventory must be carried out and updated at least annually to cross check against the previous inventory, cull out unused or expired chemicals, and check the condition of caps, bottles and labels.

Health and Hygiene

Clothing and Footwear

Full coverage shoes constructed of sturdy material shall be worn at all times. Sandals, clogs, and open toed shoes are not allowed in laboratories. Shorts and t-shirts are allowed as long as lab coats are worn when using chemical, biological, and radioactive materials. Clothing that is extremely loose or tight fitting should be avoided. Overly tight clothes, such as leggings and body suits are not recommended, as any spilled material will be held next to the skin by these garments. Overly loose clothing, long necklaces, ties, or scarves can get caught in equipment or knock over work materials. Long hair should be tied back so it does not come in contact with chemicals, biological or radiological substances or become entangled in equipment. Rings must be removed if working on equipment with moving parts or emersion of gloved hands in concentrated solutions.

Food and Drink

Food and drink should not be stored or consumed in areas where chemical, biological or radioactive substances are being used or stored. Break rooms or lunchrooms must be used where available. Food and drink may only be consumed in prescribed and clearly designated areas of the lab's office area, away from lab equipment and potentially contaminated airflow. Transport of samples and chemicals are not permitted through the designated area. Equipment (e.g. microwaves), glassware or utensils that have been used for laboratory operations should never be utilized to prepare or consume food. Laboratory refrigerators and cold rooms may not be used for the storage of foods. Separate, clearly labeled appliances must be used. Sinks and drain boards used for washing food utensils should not be used for research purposes. Ice made in ice machines used to provide lab ice cannot be used for human consumption. Alcoholic beverages are not permitted on University property.

Smoking

Smoking is not allowed in any University building or on campus.

Cross Contamination Prevention
Personal protective equipment (gloves, lab coats, etc.) is not permitted in public areas of the building such as restrooms, offices, and cafeterias. In an effort to eliminate possible exposure or contamination of building fixtures and equipment, gloves shall be removed when leaving the lab. To transfer specimens or chemicals from one lab to another should use one gloved hand to handle the cart or container. The ungloved hand can be used to open doors, push elevator buttons, etc. Otherwise, this procedure should be performed using at least 2 persons, which one is completely responsible to handle the specimen or chemical.

When working with chemical, biological or radioactive substances hands shall be washed often, especially after gloves have been removed and before leaving the lab. Lip balm, cosmetics, or contact lenses should not be applied or handled in the lab. Solutions must not be pipetted or siphoned by mouth. Only mechanical pipette and siphoning aids should be used.

Ergonomics
Laboratory workers are at risk for repetitive motion injuries during routine laboratory procedures such as pipetting, working at microscopes and hoods, operating microtomes, using cell counters and video display terminals. By becoming familiar with how to control laboratory ergonomic risk factors, you can improve your comfort and productivity while lowering chances for occupational injuries.

Physical Hazards and Housekeeping

Physical hazards and poor housekeeping practices may put staff and visitors at risk of injury. Lab staff must correct or report any hazards found in the lab. Physical hazards or housekeeping issues observed outside of the lab should be reported to the appropriate maintenance division.

Trip Hazards and Spills
Trip hazards such as electrical or computer cords across floors, excess storage in walkways, etc. must be minimized. Irregular, bumpy or loose flooring should be reported to the maintenance department. Aisles, hallways and stairways must not be used for storage areas. Avoid excessive overhead storage. Shelves must be of sturdy construction, leveled, and if possible, attached to walls or cabinets so they do not tip. Do not overload shelves.

Spills must be attended to immediately. Clean--ups should follow the completion of any operation or be done at the end of the day.

Lab Equipment
Centrifuges, refrigerators, and freezers must be level to prevent samples and solutions from spilling when their doors are opened. Sharp edges or corners on equipment should be protected or equipment relocated to minimize injury. Scalpel, microtome blades or other sharp objects must be removed from equipment or covered with a protective guard when not in use. Belt and pulley systems, such as on vacuum pumps, or any other pinch points must be covered by a protective guarding.

Shared and Common Use Labs
The initial responsibility for housekeeping and the minimization of physical hazards and injuries in any shared lab or support space is the duty of all staff using the lab. It is imperative that all users clean up after themselves.

Electrical Safety

The electrical demand in laboratories has grown tremendously since some of AHU buildings and labs were designed. It is imperative that the electrical systems in these buildings are not abused or overloaded. Lab staff cannot modify, install or remove electrical systems.

Electrical Cords

Electrical cords and plugs must be inspected routinely to identify cracked insulation or broken plugs. Any equipment found with damaged cords or plugs must be removed from service until it is repaired. Wrapping broken insulation with electrical tape is not an acceptable repair method. Electrical cords cannot be run across floors, under rugs, through walls, doors, windows, over ceiling tile or around sharp edges or corners where they can be damaged or cannot be inspected for damage.

Extension Cords

Extension cords are intended only for temporary use with portable equipment. Permanent use of extension cords is prohibited. Shop made cords with receptacle boxes may not be used. The use of multi plug electrical boxes is acceptable if they have an internal fuse, but these may not be plugged into one another in series. These should be attached to a solid surface like a wall or table.

Surge Protection

The use of surge protection is recommended for all electrical equipment in all labs. These should have internal fuses and cannot be plugged into one another in series.

Sharps

Sharps (needles, broken glass, scalpels, razor blades, etc.) must not be disposed in the regular solid non-hazardous waste stream. Needles and scalpels must be placed in "sharps" boxes and disposed of as biomedical waste, no matter if they are contaminated with a biological substance or not. Syringes must be disposed of in the red sharps box for biomedical waste disposal whether or not they are contaminated. Broken glass must be placed in a rigid puncture resistant container.

Uncapped needles must not be left where someone may sustain a needle stick. Used needles cannot be recapped, broken, bent or sheared. If the needle and syringe are to be used again, it should be placed in a wide mouth jar, beaker, or otherwise secured so that staff using the area are protected from a needle stick injury. New needles (and syringes) should be stored in a secure cabinet.

Razor blades, microtome blades and other objects that may puncture trash bags or boxes, no matter if they are contaminated or not, must be disposed of into sharps boxes. Biologically contaminated sharps must be properly inactivated before disposal.

Working Alone

Hazardous experiments shall not be performed alone in a laboratory. Persons working alone shall make arrangements with other persons in the building to check on them periodically. It is vitally important not to cover or black out lab door windows so the lab may be observed (unless an experiment is being performed that requires little or no exposure to light and that the proper laboratory personnel are notified prior to the experiment).

Unattended Operations

Operations and experiments that continue unattended for several hours or overnight must be pre-

-approved by the Laboratory Coordinator and PI. Plans should be made to eliminate the risk of hazards in the event of a failure in power, water, gas or other service. Water cannot be left running. Do not cover or black out lab door windows. Room lights should be left on and a notice placed on the lab door with the name and number of the researcher running the experiment and any pertinent information.

Laboratory Security

Laboratories must be locked if no one that has the appropriate training is in the lab. Acute toxins, select agents, controlled substances and radioisotopes must be appropriately secured. Do not hesitate to politely question anyone who does not belong in the area. If asked, it is requested that you decline to answer any questions about the contents or research being performed in the lab or the facility. If there is any concern about lab security or suspicious individuals please contact Campus Security 407-353-4002.

Visitors

- Visitors must be identified with visitor badge.
- Must be made aware of any potential hazards they may encounter in the lab.
- Wear the correct personal protective equipment for the hazards present in the lab, no matter if they are visitors or maintenance workers, no matter how long they will be in the lab.
- Abide by laboratory regulations for access and control of hazards.
- Pets are not allowed in labs. Only certified service animals may be allowed into AHU buildings.

Safety Equipment

Maintain all safety related equipment and information clearly labeled and stored in the same area so it can be easily found in an emergency.

First Aid Kits

A first aid kit shall be located in a clearly visible place in each laboratory. Additional first aid items may be required depending on the chemicals used in the lab. Consult your Safety Data Sheets (SDS) to determine the items needed in the first aid kit for your lab.

Spill Kits

AHU policy requires all labs to maintain spill control materials in the event of a liquid chemical release. Commercial spill kits including instructions, absorbents, neutralizers, and protective equipment can be purchased through a commercial laboratory supply company. A large centrally located spill kit can be used for a suite of labs under the same Laboratory Coordinator, provided it is placed near the area(s) with the highest potential for spills and is always available to all staff working in all of the suite's lab.

Preplanning

Chemical spills can be handled effectively if preplanning has been conducted. Individuals should become familiar with, and trained in proper cleanup procedures before a spill occurs. This preplanning should include consideration of:

- Likely location(s) of a spill
- Estimated quantities that may be released

- Chemical and physical properties of the material (e.g. physical state, vapor pressure, and air or water reactivity)
- Potential health hazards of the spilled material
- Personal protective equipment that will be needed
- Type of spill absorbents that will be required (see below)

A chemical spill kit can be assembled and stored in a high--density polyethylene bucket (the bucket can be used for collection of the chemical and absorbent in the event of a spill). Label the spill kit clearly. The following list of items to include in the spill kit is offered as a general guideline:

- Neutralizing agents such as sodium carbonate, sodium bicarbonate, or sodium bisulfate for acid spills.
- Inert clay absorbents such as vermiculite or cat litter can be used for most types of chemicals.
- Inert absorbent pads and pillows can be purchased from a laboratory supply company.
- Polypropylene absorbents must be used for hydrofluoric acid spills (expanded silicate absorbents may react with hydrofluoric acid). Polypropylene absorbents can be used for most other chemical spills as well. These can be purchased from a commercial laboratory supply company. The calcium Gluconate antidote will also need to be kept available in each lab that contain acids.
- A mercury spill kit (or vacuum line, flask, needle--nose pipette, and trap) for mercury spills and broken mercury thermometers.
- Personal Protective Equipment (gloves, goggles, aprons, etc.) to wear during the cleanup.
- Hazardous Waste labels, bags, and small scoop or shovel (for clay absorbents).

Paper towels, rags or sponges are not recommended for the reason that some chemicals (strong oxidizers) may ignite upon contact. Also, they are inadequate for large spills, as they do not absorb and reduce vapors as well as clay or commercial absorbents. For more information concerning chemical spill kit requirements for your lab, consult your Safety Data Sheets (SDS). Please consult the Hazardous Waste Management Manual for more information on proper disposal and handling of hazardous waste.

Fire Extinguishers and Fire Alarms

Appropriate fire extinguishers shall comply with NFPA codes 10 and 45 (National Fire Protection Association). Stored items or equipment must not block access to fire extinguishers. If a fire extinguisher is used, it cannot be rehung on the wall with it being serviced, as it will lose pressure and will not work again.

If a fire alarm sounds in the lab consider it a fire situation and act accordingly. Shut down any processes and close all fume hood sashes. Leave the building and report to the designated rally point for a head count.

Safety Showers and Eyewash Station

ANSI Z358.1 (American National Standards Institute) compliant safety showers and eyewashes must be located within ten seconds of travel time of the chemical work area. A safety shower or eyewash located in an adjacent room may be used if it meets the above ANSI standard and is accessible at all times.

Every laboratory worker should know the location and operation of the safety shower and eyewash. All safety showers and eyewash stations must be clearly identified by signs. In hallways, signs must be visible from all directions of travel. The access to the eyewash and safety showers must be clear at all times. There must be at least a 4 x 4 foot clear floor area directly beneath the unit.

The appropriate maintenance staff will periodically test all eyewash stations and safety showers. Each unit will be tagged to identify the date of the last test. Lab staff should flush out eyewash stations and safety showers monthly.

Sprinkler Systems

Combustible items must be kept below 18 inches of the sprinkler head level. Do not block or obstruct sprinkler heads in any way. Hanging or otherwise attaching articles to sprinkler piping or heads is not permitted.

Engineering Controls and Work Practices

The hierarchy of engineering controls then enacted work practices and finally the use of personal protective equipment is to be employed to keep staff safe from chemical or biological exposure. Engineering controls isolate or remove a hazard from the workplace and are considered the first line of defense against health hazards in the lab The ventilation system controlling the air flow in the lab, fume hoods, biological safety cabinets, glove boxes, local exhaust, shielding, are some of the more commonly used engineering controls in a lab setting. It is the responsibility of the Laboratory Coordinator to determine the need and type of engineering controls required for the lab.

Personal Protective Equipment (PPE)

The department or laboratory shall provide PPE to each staff member. The Laboratory Coordinator must determine the appropriate PPE needed for procedures in the lab by conducting a hazard assessment. It will be the responsibility of each staff member to use the PPE correctly and to keep it clean and in good repair. It is the responsibility of the PI and Laboratory Coordinator to enforce all policies regarding the proper use of PPE to students and visitors.

Gloves

Protective gloves shall be worn when working with hazardous materials or with materials of unknown toxicity. No glove will provide universal protection from all chemicals. Gloves must be selected on the basis of the material being handled and their suitability for the particular laboratory operation. In cases of latex sensitivity, alternative gloves must be provided.

A glove compatibility chart must be consulted to ensure the proper glove selection.
Gloves must not be worn outside of the lab. Dispose of gloves into the proper container per guidance of lab coordinator or principle investigator. Biologically contaminated gloves should be thrown into the biohazard (red) bag; while other chemically contaminated gloves may not. If a compound must be transported to another location, use a secondary sealed, spill-proof, container and wear one glove on the hand holding the container. Use the un-gloved hand to open doors, push elevator buttons, etc.

Eye Protection

Eye protection shall be worn at all times when working with chemical, biological or radiological

substances. Safety glasses must have side shields and conform to ANSI Z 87.1. Ordinary prescription glasses will not provide adequate protection from injury to the eyes.

Safety goggles or face shields shall be utilized where there is a possibility of splashing chemicals, violent reactions or flying particles. Specific goggles shall be worn for protection against laser hazards, ultraviolet or other intense light sources.

Contact lenses are not to be worn in the work areas of any chemical, biological or radiological laboratories. If they are required for medical reasons, safety goggles must be worn. Standard safety glasses or face shields will not provide adequate protection.

Lab Coats

Laboratory coats or gowns will need to be worn over street clothes or exposed skin when chemical, biological or radiological substances are being used. Lab coats should be buttoned and be long enough to cover the wearer to below the knees. Lab coats should not be removed from the lab area. If they need laundering, they should be washed by AHU Environmental Service Personnel.

Other PPE

Other types of PPE, such as aprons, dust masks, thermal protection, coveralls, hearing protection, etc. may be required as determined by the laboratory's hazard assessment.

Emergency Procedures

Medical Emergencies

- Remain calm.
- Initiate lifesaving measures as needed.
- Call for medical help.
- Do not move any injured person unless absolutely necessary.
- Keep the injured person warm.

In all cases of a medical emergency or injury, it is advised that the victim seek medical attention Hospital Emergency Room or the emergency care provider in your area. Escort the victim to the facility; do not let them go alone.

First Aid

Provide on--site first aid treatment to stop bleeding, cool burns or, in the event of chemical splash, by flushing with water at a safety shower or eyewash.

Chemical Splashes

- **Over a large area of the body:** Quickly remove all contaminated clothing while under the safety shower. Immediately flood the exposed areas with water for at least 15 minutes; resume if pain returns. Wash off chemicals by using a mild detergent soap and water; do not use neutralizing chemicals or salves. Seek medical attention.
- **On a confined area of the skin**: Immediately flush with cold water for at least 15 minutes and wash by using a mild detergent or soap and water. Remove any jewelry in the affected area. If a delayed action of the chemical is possible (e.g. phenol, hydrofluoric acid, methyl and

ethyl bromides) obtain medical attention promptly.

- **Eyes**: Immediately wash the eye and inner surface of the eyelid with copious amounts of water for 15 minutes. Check for and remove any contact lenses if possible without causing further injury. Hold the eye open to wash thoroughly behind the eyelids. Have injured worker move eye side-to-side and up and down during rinsing. Obtain medical attention immediately after rinsing.
- **Hydrofluoric burns**: The area should be rinsed immediately with running water for 2-5 minutes. A calcium gluconate compound must be applied to the area. Seek medical treatment immediately.
- **Phenol:** has the ability to penetrate the skin causing severe burns. It will anesthetize the area so little or no pain may be felt. In case of exposure, flush with water immediately. Seek medical attention immediately. Substances such as polyethylene glycol may be used to neutralize and treat the burn in the hospital. Contaminated clothing should be disposed of and not saved.
- **Cryogen or dry ice burns (frostbite):** Flood or soak with tepid water, do not use hot water. Seek medical attention.

Ingestion of a Toxin
Dilute the poison by having the victim drink large amounts of water (do not give liquids to an unconscious or convulsing victim). Attempt to learn what the ingested substance was. Obtain medical treatment immediately. Save the label or container for transportation with the victim to the medical facility.

Inhalation of Chemical Fumes
Take the individual to fresh air, seek medical assistance immediately, and provide artificial respiration or CPR as needed.

Fire
If clothing is on fire, help the individual to the floor and roll him/her around to smother the flames, or if a safety shower is immediately available, douse the person with water. Seek medical attention.

In case of a fire emergency-- remember the acronym **R*A*C*E**
R- Rescue: Without entering a hazardous situation or area, rescue and remove all individuals from the area.
A- Alarm: Activate alarms/alert occupants in the building.
C- Confine: all doors, windows and access to the affected area must be closed to confine spread of the fire and smoke. All access must then be restricted to emergency response personnel only.
E- Evacuate: evacuate the area to allow the emergency response crews to fight the fire. Report to the assigned rally point for a head count.
OR
E- Extinguish -- attempt to extinguish the fire only if all of the following criteria can or have been met:

- Both the 911 response and building alarm have been activated.
- Training has been received on how to use a fire extinguisher.
- The proper extinguisher is available.
- The fire has not spread from its point of origin.

- The fire is still small enough to be handled by the fire extinguisher to be used.
- The fire can be fought with your back to the exit to ensure there is a means of escape in the event that the attempt to extinguish the fire fails.
- If the fire is not extinguished after using one fire extinguisher, close all doors and leave the building.

Chemical Spills

Laboratory staff members should clean up only small incidental spills that constitute a minimum hazard. If large chemical spills occur, the Laboratory Coordinator needs to contact the AHU Security Department immediately. All lab staff should become aware of procedures to follow and precautions to take for the chemicals they are using. For more information on how to handle and dispose of hazardous chemicals please refer to the Hazardous Waste Management Manual.

Incidental Chemical Spills

1. Alert personnel in the immediate area.
2. Avoid breathing vapors and try to determine what has spilled.
3. Turn off ignition sources in the immediate area.
4. If someone has been splashed with chemical, immediately flush the affected area with copious amount of water for at least 15 minutes.
5. Wear protective equipment including safety goggles, disposable gloves, shoe covers, and long sleeve lab coat.
6. Use a commercial kit or the materials to pick up spilled materials. Confine the spill to a small area by diking the perimeter of the spill first, continuing towards the center.
7. Place the used absorbent in a plastic bag or bucket and label it with a Hazardous Waste label. Include it in the next hazardous waste pickup.
8. Clean area with water.
9. For acids or base spills: Neutralizing these spills may release hazardous fumes. If you are unsure of the resulting reaction, use an inert absorbent.
10. For alkali metals: Smother the spill with a special, dry powder extinguisher.

Large Chemical Spill/Release

1. Avoid breathing vapors.
2. Quickly identify the spilled material if it can be done safely.
3. If the spill involves a flammable liquid, turn off all ignition sources if it can be done safely.
4. Immediately evacuate the area, closing all doors.
5. If someone has been splashed with the chemical, immediately flush the affected area with copious amounts of water for at least 15 minutes.
6. Keep all personnel away from the spill area until Emergency personnel arrive to evaluate and control the situation. Place a sign at all doors to the spill location advising personnel **not** to enter the room.
7. Contact AHU security department immediately.
8. Personnel most knowledgeable about the spilled material should be available to provide information to Emergency personnel.

Emergency Procedures

Immediately request emergency response assistance through the University Security department

under any one of the following circumstances:

- The release requires immediate attention because of imminent danger;
- The release requires evacuation/control of employees beyond the immediate spill area (e.g. any toxic material spill in a hallway or other public area)
- The release poses a serious threat of fire or explosion;
- The release may cause high levels of exposure to toxic substances that are uncontained
- The situation is unclear or important information is lacking.

Laboratory Equipment

The types of equipment and instrumentation used in University laboratory settings are as diverse as the various research performed. Although each will have its own specific safety requirements, there are some general guidelines to follow whenever operating any lab equipment and instrumentation:

- Always keep the manufacture's operating manual with the instrument or in a known location at the lab.
- Follow recommended maintenance procedures outlined in the manual.
- New operators should be trained by qualified lab personnel and familiarize themselves with the operating manual, including all pertinent safety information.
- Never remove hazard--warning labels from an instrument.
- Ensure that all equipment is grounded.
- Have a certified technician perform or oversee repairs.
- Disconnect equipment from the power source whenever conducting maintenance on the instrument.
- If the equipment is used near any source of water, ensure that it is plugged into an outlet equipped with a Ground Fault Circuit Interrupter (GFCI). Note: do not plug continuous running equipment such as freezers, into GFCI outlets.
- Be aware of, and be trained in the unique hazards of your instrument. (i.e.: lasers, UV light, radiation sources, etc.)
- Use protective equipment recommended by the manufacturer when using the instrument. (i.e.: hearing protection, face shield, etc.)

Refrigerators, Freezers, and Cold Rooms

Refrigeration systems, whether it is an appliance or building system, may not be modified or repaired by laboratory staff. Certified refrigeration mechanic should be contacted to work on these systems. The refrigerant gas must be collected and recycled and must not be released to the environment. For more information on the labeling of chemicals and chemical containers please refer to the Hazardous Waste Management Manual.

Labeling

Every refrigerator, freezer, and cold room must be clearly labeled to indicate whether it is suitable for storage of flammables, biological or radiological materials. Household refrigerators and freezers must be labeled "Danger – Do not put flammable liquids in this refrigerator/freezer", food refrigerators and freezers must be labeled "Food Only".

Flammable Storage Units

Household refrigerators and freezers are not equipped with electrical safe controls and shall not be used to store flammable liquids. The flammable storage refrigerator/freezer is constructed with its

controls mounted outside the storage compartment. This type of refrigerator is suitable for storing flammable liquids and is labeled by the manufacturer as such.

Centrifuges

Each operator must be trained on proper operating procedures. The use of centrifuges requires that they be balanced to prevent damage to the unit, the area or cause an injury to the operator. Any centrifuge that makes noise or vibrates must be stopped immediately and checked for balancing of the rotor. A log should be kept detailing operation for centrifuges and rotors.

- Label centrifuges used for biohazards or radioisotopes.
- Check the rotor for rough spots, pitting, and discoloration. If discovered, check with the manufacturer before using. Use professional rotor inspection services as required or recommended by the manufacturer.
- Ultra-centrifuge rotors require a log of rotor use and inspection. Damaged rotors must be removed from service immediately.

Vacuum Systems

Vacuum systems should not be used for any reason other than to pull vacuum on equipment. Do not use in-house plumbed or secondary vacuum pumps to remove water, dust, or other materials, even if there is a trapping reservoir to collect the material.

All vacuum systems should be used with a secondary containment trap. Cold traps must be in place when flammable vapors are extracted by vacuum. It is strongly recommended that flow restrictors be used in line to minimize solvent loss.

A hydrophobic in-line filter should be placed between the last collection vessel and the vacuum port in systems used for aspirating liquids. This is recommended for both plumbed vacuum lines and for portable vacuum pumps. This filter will stop debris or liquid from entering the system and help to prevent contamination or degradation of the vacuum system.

Heating Equipment

Steam heated devices shall be used rather than electrically heated devices or Bunsen Burners whenever possible. Steam-heated devices do not present shock or spark hazards and can be used with assurance that their temperature will not rise beyond 100°C.

Electrical Heating Devices

Only hot plates with heating elements enclosed in a glass, ceramic, or insulated case should be used in laboratories. All electrical equipment must be UL approved.

Gas Burners

Where burners are used, distribute the heat with a wire gauze pad. Tubing for the gas should be checked to ensure it is properly attached, with clamps and is not cracked. Burners should not be used in fume hoods or biological safety cabinets, as the continual high volume airflow through these units may extinguish the flame and go unnoticed. Burners must not be left on when not in use.

Cooling Equipment

Running tap water should not be used for cooling of any experiment or equipment for longer than 30 minutes. If cooling water is needed for longer periods, a self-contained cooling system must be used.

Special care should be taken if dry ice or a cryogenic liquid, such as liquid nitrogen or helium is used in a cooling system.

Glassware and Hoses

Careful handling and storage procedures should be used to avoid damaging glassware. All glassware should be inspected prior to use. Damaged items should be discarded or repaired.

Prior to use, all tubing and connections must be inspected. Replace cracked or split tubing before use. Ensure that all connections are secured, and the use hose clamps are required.

Hand protection should be utilized when inserting glass tubing into stoppers or when placing rubber tubing on glass hose connections. Tubing should be fire polished or filed smooth and lubricated. A cloth should be wrapped around the glass. Hands should be held close together and the glass inserted with a slight twisting motion, avoiding excessive pressure.

Disposal of Used Equipment

All laboratory equipment used in conjunction with chemical, biological or radioactive substances must be certified that it is safe for disposal or storage prior to its removal from the lab. The department or lab will be responsible for the decontamination and/or disinfection of the equipment, draining all liquids and oils, and certifying that these procedures have been done properly. More information on disposal of contaminated materials can be found in the Hazardous Waste Management Manual.

- All equipment must be cleaned by the lab staff prior to the initiating the disposal process.
- Refrigerants (Freon) must be removed from any equipment prior to disposal. This may include refrigerators, freezers, centrifuges, etc.
- To dispose of a biological safety cabinet, it must be decontaminated by a certified technician prior to disposal.

Utility Systems

Laboratory staff may not perform any modifications of any utility systems in buildings or labs. No part of the ventilation, electrical, plumbing (water and gas) may be tapped into, repaired, removed added or tampered with in any way by anyone except Facility Operations personnel or licensed contractors. If work needs to be done on these systems, please submit a work order.
If there are any concerns about the electrical system, equipment or need to upgrade it within a lab area, contact the appropriate personnel to assess the requirements and concerns.

Fume Hoods and Ventilation Systems

Ventilation systems for laboratories are normally designed to provide 6–12 air changes per hour at a slightly negative pressure relative to hallways and office space. It is important to keep lab doors and windows closed as much as possible for proper pressure balance and ventilation of the lab.

Chemical fume hoods are intended to remove vapors, gases and dusts of toxic, flammable, corrosive or otherwise dangerous materials. It is important for lab staff to understand how the chemical fume hood in the lab functions. All laboratory personnel must be trained in proper use of fume hoods.

Proper Use of Fume Hoods

With the sash lowered to the indicated level for proper airflow, laboratory fume hoods can also afford

workers protection from such hazards as chemical splashes or sprays and fires. Sash heights are posted to each hood. To set the sash at the indicated level, measure from the floor of the hood, as the opening should include the area under the airfoil.

If the hood's low airflow alarm is sounding the lab must immediately end their work in the hood, close all chemical containers and close the sash. Contact the appropriate maintenance personnel to have the ventilation system repaired. Do not mute, ignore or disconnect any fume hood alarm.

Fume Hood Repairs
If a hood needs to be repaired, the appropriate maintenance group will not perform any work unless the lab staff stop all work in the hood that is not functioning properly, call in the work order, clear the hood of chemicals or equipment and clean the hood of any potential contamination.

Plumbing Systems
Tap water will not be left flowing for prolonged experiments for longer than 30 minutes or left unattended. A refrigerated recirculating system must be used to cool experiments or equipment to minimize potential damage from leaks and flooding. The use of these closed loop systems is required to minimize the wasting of this valuable resource.

Isolated or unused sinks and floor drains may be a source of foul odors if the traps dry out. Please ensure that all sinks have had water periodically run into them to fill the trap. If a sink is in an isolated area and will not be used for some time, please contact the maintenance department to have it sealed or have the trap filled with mineral oil. Mineral oil will not evaporate and is environmentally safe. Many AHU buildings have plumbed gases, such as natural gas or air. These systems are regulated within the building and do not need additional regulators attached prior to use. All other use of these systems would be identical to the use of compressed gas cylinders: all hoses leading from the stopcock to the use areas need to be clamped, all hose connections should be leak tested.

Chemical Hygiene Plan

Transporting Chemicals
Individuals transporting chemicals must be familiar with the material's hazards and know what to do in the event of a release or spill. Safety Data Sheets (SDSs) are a good source for this information. Materials that are unstable, explosive, or extremely or acutely hazardous should not be moved from one building to another.

Transporting Chemicals within the Lab
- Always use appropriate chemical resistant gloves and eye protection.
- Large containers or especially hazardous chemicals should be carried in a secondary container.
- Never move visibly degrading chemicals and containers.
- Be aware of your surroundings: potential trip hazards, other workers, etc.

Transporting Chemicals from Lab to Lab
- Containers and bottles must be labeled.
- Spill absorbent materials and MSDS for the chemicals must be available at all times.

- When chemicals are carried, they should be placed in a secondary container such as an acid carrying bucket, or other appropriate container to protect against breakage and spillage.
- Use sturdy carts for transporting multiple, large, or heavy containers; the cart should have wheels large enough to negotiate uneven surfaces without tipping or stopping suddenly.
- Carts used for secondary containment must have a liquid tight tray with lips on four sides.
- The chemicals should not be transported during busy times, such as during class changes, lunch break, etc.
- Hazardous chemicals should be transported on freight elevators, wherever possible to avoid exposure to persons on passenger elevators.
- Remove gloves to open doors and push elevator buttons, etc.
- Never leave chemicals unattended.

Chemical Storage and Compatibility

General Rules for Chemical Storage

- Do not store liquid chemicals above shoulder height.
- Flammable chemicals in amounts exceeding 10 gallons must be stored in flammable storage cabinets or safety containers.
- Bottles may not be stored on the floor unless they are contained in tubs or other secondary containment.
- Excessive chemical storage in hoods is not acceptable; this practice interferes with the airflow in the hood and reduces the available workspace.
- Chemical waste shall be placed at the designated accumulation area, in appropriate receptacles, properly labeled and segregated by hazard class.

Solid or Powdered Chemicals

Most solid chemicals may be shelved alphabetically with the following exceptions:

- Ensure that phenol crystals are separated from oxidizers
- Cyanide compounds must not be stored near acids. (Accidental mixing may release cyanide gas.)
- Flammable solids should be stored segregated from other solids or in Flammable Storage Cabinets.
- Powdered metals should be stored as directed on the bottle label or MSDS. Storage of some metals may depend on the conditions in which they are packed (e.g., under a flammable solvent), which may require storage in flammable storage cabinets.

Liquid Chemicals

All liquid chemicals must be segregated by hazard classification and stored only with compatible substances. The following categories of liquid chemicals should be segregated from other categories.

- Acids: Organic acids should be kept separate from inorganic (mineral) acids. For example, store acetic and formic acids separate from hydrochloric and sulfuric acids.
- Bases: May react violently with acids, oxidizers or flammables.
- Oxidizers: Keep away from acids, bases, organics and metals; keep cool. Examples of strong oxidizers: Perchloric acid, nitric acid.

- Flammable liquids: The excess over 10 gallons in any workspace must be stored in flammable storage cabinets or in safety containers. Keep separate from acids, bases, and oxidizers.
- Toxic or poisonous liquids: Must be segregated and stored separately, as they could be released and/or intensified with reactions with the other chemicals. Examples of this may be cyanide solutions. Other chemicals, such as formaldehyde should be stored in plastic bottles at the lowest shelve or storage space. This will minimize the potential for spillage.
- Mercury: Must be stored in non-breakable secondary containers and kept on a bottom shelf of a closed cabinet.
- Non-hazardous/inert liquids: May be stored with any other category, but it is recommended that they also be segregated for consistency.
- Accumulated chemical waste: Liquid chemical wastes must be stored by compatibility.

Flammable Chemicals

Flammable substances are the most commonly stored hazardous materials in the laboratory. The ability to vaporize, ignite, burn or explode varies with the specific type or class of substance.

An indicator of the flammability of a solvent is its flash point, or the lowest temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air. Flammable liquids have flash points below 100°F (37.8°C); Combustible liquids have flash points between 100°F (37.8°C) and 210°F (93.3°C). This information is usually available on the label affixed to the chemical container or on the MSDS.

The most hazardous flammable liquids are those that have flash points at room temperature or lower, so extra care in storing and using these must be taken.

For a fire to occur, three conditions must exist: a concentration of flammable vapor that is within the flammable limits of the substance, air and, a source of ignition. Elimination of any one of these three will prevent the start of fire. Because spillage of a flammable liquid is always a possibility, strict control of ignition sources is mandatory.

When flammable materials are being used in a laboratory, close attention should be given to all potential sources of ignition. The vapors of many flammable liquids are heavier than air and capable of traveling considerable distances. This possibility should be recognized, and special note should be taken to ensure that all possible ignition sources are eliminated.

Handling Flammables

The following guidelines should be observed in handling flammable liquids:

- Flammable liquids should be handled only in areas free of ignition sources.
- Smoking is not permitted in AHU facilities.
- Never use an open flame near flammable liquids.
- Flammables should not be heated with an open flame. Other types of heat sources, such as a steam bath, water bath or heating mantle should be used.
- Transfer flammable liquids with caution. The friction created by flowing liquids may be sufficient to generate static electricity, which may cause a spark and ignition. Therefore, ground all large containers (5 gallons or more) to the building or special ground system. Bond all metal and other containers together before pouring from them. Where pouring into a plastic

container, a copper rod that is bonded to the grounded supply container may be placed into the container and the flammable liquid poured over it. This will dissipate the charge.

- Flammable liquids should be dispensed and used in a hood or well-ventilated area so that flammable vapors will not accumulate.
- Substitute non-flammable liquids whenever possible.

Storage of Flammables

- Storage of flammable materials should comply with those requirements specified in the NFPA 45 and AHU Environment, Health and Safety Office regulations and guidelines.
- Keep only small quantities (500 ml or less) of flammable materials available for immediate use.
- Large amounts (greater than 500 ml) of flammable liquids should not be stored on the open bench top. Quantities greater than ten (10) gallons stored in a laboratory will require the use of safety cans or a flammable storage cabinet.
- An approved safety can with a self-closing cover, vent, and flame arrestor is the best container for storing flammable liquids or waste solvents in small quantities. An ordinary five-gallon container does not provide adequate protection in case of fire.
- Fifty five (55) gallon drums are not allowed in labs.
- For cold storage of flammables only certified explosion proof or explosion resistant refrigerators and cooling equipment must be used.
- Storage of flammable liquids in cold rooms may be permitted under certain conditions.
- All large metal containers (5 gallon or more) must be grounded and bonded to a grounding source (specialty installed electrical ground or to copper piping).

Corrosive Chemicals

Corrosives consist of four major classes: acids, bases, dehydrating agents and oxidizing agents. Inhalation of the vapors of these substances can cause severe respiratory tract irritation. Contact with these chemicals may cause burns to the skin, respiratory tract and eyes.

Acids and Bases

The following are suggestions for safe use and storage:

- Store separately in a cool ventilated area, away from metals, flammables and oxidizing material.
- Secondary containment, such as chemical resistant tubs or bottle carriers should be used to isolate bottles.
- The storage area should be checked regularly for spills and leaks.
- Suitable spill clean-up materials must be available.
- Always pour acids into water, never the reverse.
- Cap bottles securely. The only exception to this will be the loose capping of mixtures if they generate gases during storage. These should be stored in fume hoods or vented cabinets.
- Clean up spills promptly. Do not leave residues on a bottle or lab bench where another person may come in contact with them.
- Wear protective clothing and equipment when handling acids or bases. This shall include the proper chemical resistant gloves, apron and eye protection.

Five acids deserve special attention because of the hazards they pose. These are: nitric acid, perchloric acid, picric acid and hydrofluoric acid. Criteria for storage and handling are as follows:

- **Nitric acid** is corrosive and its oxides are highly toxic. Because nitric acid is also an oxidizing agent, it may form flammable and explosive compounds with many materials (e.g., ethers, acetone and combustible materials). Paper towels used to wipe up nitric acid spills may ignite spontaneously. Nitric acid should be used only in a hood and should be stored away from combustible materials.
- **Perchloric acid** may form unstable, and potentially highly explosive compounds with many organic compounds and metals. Unstable perchlorate crystals may collect in the ductwork of fume hoods and cause fire or violent explosions. Perchloric acid should be used with extreme caution and only in a fume hood designed for its use. A perchloric acid hood has corrosion-resistant ductwork and wash-down facilities. Minimum quantities of perchloric acid should be kept on hand and the container should be stored in a glass tray that is deep enough to hold the contents of the bottle. Perchloric acid must be dated when received into the lab and again when opened. It should be disposed of after one year since explosive crystals may form.
- **Picric acid** can form explosive compounds with many combustible materials, especially when dry. When the moisture content decreases to less than 10%, picric acid will become unstable and may explode from being shaken, exposed to sudden changes of temperature, or from the friction created by opening the cap. Picric acid should be dated, stored as a flammable solid and not kept for extended periods.
- **Hydrofluoric acid (HF)** is extremely corrosive and will weaken glass. All forms (dilute, concentrated, or vapor) can cause serious burns. Burns from hydrofluoric acid may not be felt immediately, may heal slowly and can be very painful. Inhalation of HF mists or vapors can cause serious respiratory tract damage that may be fatal. Therefore, hydrofluoric acid should be used in a suitable fume hood with proper gloves, safety glasses and lab coat being worn. This compound may only be stored in compatible containers, such as high or low--density polyethylene or Teflon.

    - Any lab using HF must have calcium gluconate available as a remedy for exposures. Immediately after an exposure, the area should be rinsed with running water for 2-5 minutes. The calcium gluconate compound must be applied to the area. Medical treatment must be sought immediately. This is a pharmaceutical product that does expired and must be replaced periodically.
- **Chromic acid and chromerge** solutions need to be handled with extreme care. If these are being used as cleaning solutions for glassware, it is recommended that they be replaced by other non-chromic acid compounds, such as “No-Chromix”. Their disposal is expensive. They may be used with care if there are no other alternatives.

Oxidizers

Included in this class of chemicals are nitrates, permanganates and oxides. These compounds present fire and explosion hazards that can occur on contact with organic compounds and other oxidizing substances. Suggestions for safe use and storage:

- Oxidizing agents should be stored separately from flammable liquids, organics, dehydrating agents and reducing agents.
- Strong oxidizing agents should be stored and used in glass or other inert containers. Corks and rubber stoppers should not be used.

- Oxidizing agents should be used with caution in the vicinity of flammable materials.

Dehydrating Agents

These include concentrated sulfuric acid, sodium hydroxide, phosphorus pentoxide and calcium oxide. To avoid violent reactions and splattering, these chemicals should be added to water, never the reverse. Because of their affinity for water, these substances cause severe burns on contact with skin.

Compressed Gas Cylinders

It is important that valves caps are not misplaced. Cylinders cannot be transported or returned to the vendor without a valve cap.

All cylinders must be periodically tested for internal integrity. This hydrostatic testing is mandated for all cylinders and will be the responsibility of the Laboratory Coordinator. If a cylinder has past the deadline for hydrostatic testing, it must be taken out of service until it has been tested and recertified for use.

Cylinder Safety

The following rules are intended to highlight and summarize the most common safety concerns regarding the handling and storage of compressed gas cylinders.

- Know the chemical and physical properties of the gases
- Cylinders must be secured by use of chains, straps, racks, base plates or carts (regardless of cylinder size) anytime they are in use, being moved or stored.
- Cylinder storage areas must be placarded with NFPA 704 signage.
- All cylinders must be labeled with contents (do not rely on color codes) and stage of use (e.g., "full," "in use," "empty").
- Store and use in well ventilated areas, away from heat or ignition sources.
- Store oxygen away from flammable gases. Reactive gases should be stored separately.
- The use and storage of flammable gases must be minimized.
- Do not strike or allow cylinders to strike against one another
- Metal cylinder caps for valve protection should be kept on at all times when the cylinders are not in use.
- A proper pressure regulator is required during use; improvised adapters are not allowed.
- Use regulators specific for the type of gas contained in a cylinder; they are not interchangeable.
- Do not use Teflon tape or lubricants on regulator threads.
- Release pressure and close valve at the end of the day's use; do not rely on a regulator to stop the gas flow.
- Handle empty cylinders with the same care as full cylinders.
- Transport cylinders only on a hand truck or other cart designed for such purpose; cap valve must be in place when transporting cylinders.
- Do not handle more than one cylinder at a time unless a cart designed for such purpose is utilized.
- Store full cylinders in a cool, well ventilated and protected area, away from emergency exits.
- Cylinders should never be stored horizontally.
- Do not let the temperature of the cylinders exceed 38° C (100° F).

- Do not store corrosive gases for more than 6 months.
- Never attempt to refill a cylinder 22. Do not put cylinders into freezers.
- Report all cylinders in questionable condition to the Laboratory Coordinator.

Cylinder Disposal
It is highly recommended that the laboratory or department establish an account with suppliers who allow the return of unused gas and empty cylinders.

Flammable Gases
Flammable gas should be minimized in a laboratory. Do not store extra cylinders of flammable gas in the lab. Flammable gases need to store away from oxidizer gases, such as oxygen or nitrous oxide.

Cryogenic Liquids and Dry Ice

Cryogenic Liquids
The principal hazards of cryogenic materials are frostbite from contact with skin; asphyxiation caused by oxygen displacement; and potential fire as the result of a release of a flammable gas.

The following is general safety precautions for the use and storage of cryogens typically used at the University such as liquid nitrogen or helium. Other types of cryogens (liquid oxygen, hydrogen, etc.) require further precautions. Please refer to SDS.

- Eye protection must be worn whenever cryogenic liquids are handled, as splashing is always a possibility. Face shields are strongly recommended.
- Thermal protective gloves with tight fitting cuffs, extending to the mid forearm or elbow shall be worn. Avoid wearing jewelry if possible. If not, jewelry must be completely covered by the gloves.
- Full shoes and long pants (no cuffs), long sleeves, and full coverage shoes should be worn.
- Non-insulated metal pipes containing cryogenic fluids must be kept clear of combustible materials in order to minimize the fire potential caused by oxygen enrichment of condensed air.
- Cryogenic gases are capable of causing asphyxiation by displacing breathable air and therefore should only be used and dispensed in well ventilated areas.
- A pressure relief valve should be installed on dewars to avoid quick and violent pressure changes when cryogens vaporize.
- Exposed glass portions of the container should be taped to minimize the flying glass hazard if the container should break or implode.
- If a dewar or similar cryogenic container ruptures or releases, vacate the area immediately.
- Do not transport a cryogenic liquid in a closed vehicle. These must be secured to open beds or carts.
- In case of a splash, immediately remove any clothes that may have been splashed. Flood or soak affected area with tepid water. Seek immediate medical attention for any cryogenic frostbite injuries.

Dry Ice Storage and Handling

- Wear safety glasses and thermally protective gloves when handling dry ice.
- If dry ice has been in a closed room, cold room or freezer, open the doors and allow adequate ventilation before entering or retrieving the dry ice.
- Store dry ice in a thermally insulated container. The thicker the insulation, the slower it will sublimate (turn into carbon dioxide gas).
- It is important to remember that carbon dioxide is heavier than air, especially when obtaining dry ice from chest freezers or coolers. Do not lean into dry ice coolers, as there will be no oxygen.
- Ensure the door is braced so it will not shut down on the person retrieving the ice.
- Wear a face shield whenever grinding or crushing the solid.
- Do not transport dry ice in an enclosed vehicle without allowing for ventilation.
- Leave area containing dry ice if you start to feel dizzy, pant or have shortness of breath.

Highly Reactive and Potentially Explosive Chemicals

When chemical reactions are considered safe, it is generally because the reaction rate is relatively slow or can be easily controlled. Certain reactions proceed, however, at an extremely rapid rate and generate intense heat that they may result in explosion. Care should be taken to ensure there is sufficient cooling and surface area for heat exchange.

Many chemical reactions may be handled safely if preliminary planning has been adequate. Planning an experiment should include knowledge of the reactivity, flammability and toxicity of the chemicals used in and produced by the experiment. Care must be taken so as not to contaminate the reactive compound and triggering an uncontrolled or no planned reaction.

Lab personnel should consult with the Laboratory Coordinator when planning an experiment in which hazardous materials are used or hazardous conditions may occur. Such planning shall include selection of the proper safety procedures and equipment as well as consideration of the possibility of a power failure, equipment breakdown or fire.

Pyrophoric Materials

These compounds (such as phosphorus or lithium) are air reactive and require specific storage and use conditions. Most should be stored under mineral oil or other conditions.

Water Reactive Materials

Substances such as potassium and sodium metals will require special storage to prevent contact with water or high humidity conditions.

Peroxide Forming Compounds

Organic peroxides are a class of compounds that have unusual stability problems that make them among the most hazardous substances handled in laboratories. As a class, organic peroxides are considered to be powerful explosives. They are sensitive to heat, friction, impact and light as well as to strong oxidizing and reducing agents. All organic peroxides are flammable.

Requirements for safe use and storage of ether and other peroxidizable materials:

- Ethers and peroxidizable materials should be ordered only in small quantities.

- All peroxidizable materials should be stored in a cool place, away from light.
- Metal cans are preferable; do not store ethers in ground glass stoppered bottles, as they do not seal adequately.
- These must be dated upon receipt and when opened.
- They should be discarded within a year after receipt if unopened, or within six months of opening.
- Containers that are showing signs of prolonged storage or age (such as label deterioration or corrosion) should be disposed of.
- Ethers must always be handled in a hood to assure proper ventilation. This will protect individuals from inhaling the vapors and prevent accumulation of explosive concentrations of the vapor.

Mercury

This toxic element must be stored in containers such as Nalgene bottles that will withstand the weight of the substance and still be manageable to move and handle. The container should be stored in a secondary container, such as a pail or other similar tub to contain the mercury in the event the container fails. This may then be stored on the lowest shelf available to keep the excessive weigh from surprising staff when lifting the container from upper shelves. Under no circumstances should this compound be stored in open beakers, jars etc. A mercury spill kit must be on hand in any lab that stores this substance.

When using mercury in manometers or under pressure, it is vitally important to have all hoses secured with hose clamps. Any open end of the manometer will need to have tubing attached and placed in a collection bottle to protect from a spill caused by over pressurizing of the unit.

It is strongly recommended that all mercury be eliminated from labs. As thermometers are replaced, non--mercury thermometers should be purchased.

Metals

Alkali Metals

Alkali metals (e.g., sodium and potassium) react violently with water and decompose the water to give off hydrogen, which may be ignited by the heat of reaction. Alkali metals can ignite spontaneously in air, especially when the metal is in powdered form and there is highly humid air.

Suggestions for safe use and storage include:

- Store alkali metals under mineral oil or kerosene.
- Avoid using oils containing sulfur since a hazardous reaction may occur.
- Only special class D dry powder fire extinguishers may be used on alkali metal fires.
- Waste alkali metals must be placed in a labeled, leak proof container, covered with mineral oil and disposed of.

Metals Powders

Finely powdered metals that come in contact with acids may ignite and burn. Metal powders can also create a dust explosion hazard when the powders become airborne in area where a spark or flame is present. In addition, metal powders are subject to rapid oxidation, which may result in a fire or

explosion.

Controlled Substances and Acute Toxins

All DEA controlled substances (US Department of Justice, Drug Enforcement Administration, Office of Diversion Control) and prescription drugs require specific procedures for storage, use and disposal. An outline of the policy is as follows:

- Each PI must be licensed to procure and administer DEA controlled substances. Sharing of permits or allowing others not directly supervised by the permit holder to work DEA controlled substances is not allowable by law.
- To procure and administer prescription drugs, a researcher must either hold a medical practitioner's license in the state of Florida, or obtain a registration exemption number from the state of Florida.
- Detailed records must be kept for purchase, use and disposal of DEA controlled substances. This inventory must be updated whenever the quantity of the substances changes, i.e.: use or disposal.
- All laboratory staff members administering the substances must be authorized.
- All DEA controlled substances and prescription drugs must be stored in a secure area.
- All DEA controlled substances and prescription drugs must be disposed of properly. Acute toxins are required to be securely stored in a locked cabinet or freezer/refrigerator.

Chemical Waste Disposal

Chemicals must not be disposed of down drains, in trash, or by evaporation. Chemical wastes are required to be held at the generating location in a defined "accumulation areas" until ready for pick up. Laboratory Coordinators are required to attend mandatory classroom training. Environment, Health and Safety Office will contact all Lab Coordinators to offer training sessions. The following is a summary of the chemical waste accumulation and disposal process at AHU. Further details on proper chemical disposal practices can be found in the Hazardous Waste Management Manual.

Identification and Labeling

- The chemical waste accumulation area must be identified with a "Waste Satellite Accumulation Area Requirements" poster.
- Hazardous chemical waste containers must have the yellow Hazardous Waste label on them.
- The label must list all constituents and the percentages of each, totaling 100%.

Waste Containers

- All chemicals wastes shall be accumulated in sealable containers.
- Containers shall be kept closed during accumulation except when adding waste to a container.
- A funnel cannot be left in the container.
- Do not over fill containers; one inch of air space from the top is required to allow for expansion.

Accumulation

- Do not accumulate more than 10 gallons of waste.
- Keep solids and liquids separate.

- Segregate chemical wastes by class: acids, bases, halogenated, non-halogenated, oxidizers, and reactive.

Chemical Waste Pick Up

Fill out and submit a Chemical Waste Pickup Request form to the Environment, Health and Safety Office.

Termination of Activities at Laboratory

Proper disposition of all hazardous materials used in laboratories is the responsibility of the Laboratory Coordinator to whom a laboratory is assigned. Before a principal investigator, researcher or graduate student leaves the AHU, all samples and chemicals used or generated by that person must be clearly labeled for content and disposed of prior to their departure. If samples are being saved for future analysis, they must be properly identified and there must be a clear time-line for disposal of these samples. Any chemicals or samples left behind for future use is assigned to the Laboratory Coordinator to who will take responsibility for those items.