FAU FLORIDA ATLANTIC UNIVERSITY ***Division of Administrative Affairs***	**Environmental Health and Safety** **Policy #MAN05** Laboratory Safety Manual **Version #2.0** **Effective: 11/09/22** | **Revised: 11/09/22**

1. PURPOSE:

Cover page for FAU Laboratory Safety Manual

2. CONTENTS:

FAU Laboratory Safety Manual 97 pages.

Approved and issued by order of:

Wendy Ash Graves
Director, Environmental Health and Safety

DATE: 11/09/2022

POLICY MAINTENANCE SECTION

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ENVIRONMENTAL HEALTH AND SAFETY

Laboratory Safety Manual

Florida Atlantic University

Office of Environmental Health and Safety

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1 List of Acronyms

ACGIH – American Congress of Governmental Industrial Hygienists
ANSI – American National Standards Institute
BSC – Biological Safety Cabinet
BSL – Biological Safety Level
CDC – Centers for Disease Control and Prevention
CFR – Code of Federal Regulations
CHO – Chemical Hygiene Officer
CHP – Chemical Hygiene Plan
DEP – Department of Environmental Protection **DNA** – Deoxyribonucleic Acid **rDNA –** Recombinant Deoxyribonucleic Acid **DOT** – Department of Transportation
EH&S – Environmental Health and Safety
FAC – Florida Administrative Code
FAU -- Florida Atlantic University
FDLES – Florida Department of Labor and Employment Securities
HEPA –High Efficiency Particulate Air
IACUC – Institutional Animal Care and Use Committee
LFPM – Linear Feet per Minute
LSO – Laser Safety Officer
MSDS – Material Safety Data Sheet
NFPA – National Fire Protection Association
NIH – National Institutes of Health
OSHA – Occupational Safety and Health Administration
PEL – Permissible Exposure Limit
PI – Principle Investigator
PPE – Personal Protective Equipment
RCRA – Resource Conservation and Recovery Act
RSO – Radiation Safety Officer
SDS – Safety Data Sheet
SOP – Standard Operating Procedure

2 Purpose and Scope

The Florida Atlantic University (FAU) department of Environmental Health and Safety developed this manual in accordance with the Chemical Hygiene Plan (CHP) which complies with the provisions of the Occupational Safety and Health Administration (OSHA) standard: "**29 CFR§1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories.**"

This purpose of this manual is to identify, evaluate and control the potential physical and chemical hazards associate with FAU laboratories. This manual details the basic safe operating practices to ensure a safe environment for Principal Investigators, Lab Managers, students and any other individual (s) working in the laboratory. The Laboratory Safety Manual (LSM) must be used in conjunction with the FAU CHP.

Implementation of the guidelines in this document depends on the cooperation of department chairpersons, faculty, laboratory staff, students, Environmental Health and Safety (**EH&S**) staff and members of safety committees. Although Principal Investigators bear the ultimate responsibility for safe conditions and procedures in their laboratories, each member of a laboratory group is responsible for complying with standards put forth in this document with the common goal of promoting a healthy and safe working environment for employees and students.

There may be some situations in which proper facilities and equipment are not available for conducting project requirements. When this is the case, faculty members should consult **EH&S** for assistance in evaluating hazards and finding ways to conduct activities properly. This document should not be considered a comprehensive review of all potential hazards. Individuals with more specific questions should contact **EH&S** directly.

As a result of the diversity of the laboratory operations and activities at FAU, additional manuals, plans and requirements have been developed and are available. Laboratories working with animals, radioisotopes, biological agents and/or laboratories generating radioactive, biological or hazardous chemical waste must adhere to the procedures and policies in the appropriate plans and manuals. For more information on these additional manuals and plans, please consult below or FAU EHS.

Laboratory Closeout/Transfer Procedures
https://www.fau.edu/ehs/documents/ehs004labcloseout.pdf

Animal Research Health and Safety Plan
https://www.fau.edu/ehs/safety/safety-manuals/arhasp.pdf

Biological Safety Manual
https://www.fau.edu/ehs/safety/safety-manuals/man06v2bsm.pdf

Radiation Safety Manual for Lasers
http://www.fau.edu/ehs/info/lasermanual.pdf

Radiation Safety Manual for Laboratories
https://www.fau.edu/ehs/documents/man01radsafetymanual.pdf

Diving Safety Manual
https://www.fau.edu/ehs/info/man03v1dsm.pdf

Boating Safety Manual
https://www.fau.edu/ehs/safety/safety-manuals/man04v1bsm.pdf

3 Accountability and Responsibilities

Individual laboratory workers are responsible for their own safety and the safety of their coworkers and visitors to their laboratories. All staff, students and volunteers must demonstrate this responsibility in their actions and attitudes. It will be each worker's responsibility to wear the personal protective equipment (PPE) assigned to them, adhere to prescribed safety rules and regulations, and to know and follow all emergency procedures. Lab staff must pre-plan their work to ensure their safety and the safety of those individuals who work around them.

In addition to FAU safety policies, employees conducting research on non-FAU property shall comply with all safety and emergency response policies of the non-FAU facilities host.

The Principal Investigator (PI), Laboratory Supervisor <u>and</u> Laboratory Manager have the responsibility for controlling hazards in their laboratory, including but not limited to:

a. Completing a hazard assessment for all procedures.
b. Conducting hands-on training with laboratory personnel on potential hazards and safe work procedures.
c. Ensuring monthly safety self-inspections are conducted within the laboratory.
d. Correcting work errors and dangerous conditions immediately and implementing interim measures wherever the hazard cannot be completely abated on-the-spot.
e. Maintaining a safe work environment.
f. Selecting the proper personal protective equipment (PPE) and ensuring that it is worn.
g. Maintaining all relevant compliance records and programs.
h. Investigating the circumstances surrounding a laboratory accident and taking steps to avoid recurrence.
i. Partnering with Environmental Health and Safety to ensure that personnel with indirect or infrequent exposure to research animals are enrolled in the Medical Monitoring Program and receive proper training as referenced in Table 6.

The Division of Research shall support and assist with the implementation and maintenance of this plan. The DOR will be responsible for supporting the PI and research staff with all resources necessary to ensure safety compliance. This will include providing research training to PI and staff members and allowing for time away from work for safety training. The research department will be responsible for, or assigning a responsible party to control, maintain and supervise common use laboratories.

Colleges and Departments within each college are responsible for supporting the PI and research staff with resources necessary to ensure safety compliance. Individual departments will be responsible for maintaining and supervising common use laboratories.

Environmental Health and Safety (EH&S) shall be responsible for providing oversight, EHS expertise and monitoring compliance and implementation of all safety and environmental regulations for all campus laboratories. This will include, but is not limited to, regulation interpretation, implementation of programs, planning reviews, facility surveys, and training and educational services. EH&S shall have enforcement authority when dealing with unsafe or illegal situations.

Florida Atlantic University will aid with the compliance efforts of all staff and researchers. It will foster a culture where safety is a core value of the institution.

4 Definitions

The definitions listed below are taken directly from the OSHA Lab Standard (29 CFR§1910.1450(b)).

Chemical Hygiene Plan: A written program developed and implemented by an employer which sets forth procedures, materials, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meet the requirements of paragraph (e) of the Lab Standard.

Emergency: Any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment that results in an uncontrolled release of hazardous chemicals in the workplace.

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

Hazardous chemical: A chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees.

Health hazard: A term that includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Laboratory: A facility where the "laboratory use of hazardous materials, equipment or research with animals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis. This includes but is not limited to engineering and arts workspaces.

Academic Laboratory: A facility where curriculum-based experiments for study in science is conducted.

Research Laboratory: A facility where scientific research and investigations is conducted

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

Laboratory-type hood: A device located in a laboratory that is enclosed on five sides with a movable sash or fixed partial enclosure on the remaining side. It is designed to prevent or minimize the escape of air contaminants into the laboratory and to keep the breathing zone of the operator uncontaminated. Walk-in hoods with adjustable sashes meet this definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised, and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

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

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

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

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

Based on these definitions, the CHP will apply to all areas engaged in the laboratory use of hazardous chemicals.

Absolute A chemical substance that is not mixed; pure. For example, Absolute Alcohol, ethyl alcohol, containing not more than one percent by weight of water.

ACGIH American Conference of Governmental Industrial Hygienists, Incorporated. An organization of professional personnel in governmental agencies or educational institutions engaged in occupational safety and health programs. ACGIH develops and publishes recommended occupational exposure limits (see “TLV”) for hundreds of chemical substances and physical agents annually. (ACGIH, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634; 513-742-2020, www.acgih.org)

Acids Any chemical that undergoes dissociation in water with the formation of hydrogen ions. Acids have a sour taste and may cause severe skin burns. Acids turn litmus paper red and have pH values of 0 to 6.

Action level an exposure limit designated in a WAC, generally derived as an 8-hour time- weighted average, which requires the employer to initiate certain required activities such as exposure monitoring and medical surveillance.

Acute health effect an adverse effect on a human or animal body, with severe symptoms developing rapidly and coming quickly to a crisis. Also, see “chronic health effect.”

Acute toxicity the adverse (acute) effects resulting from a single dose of, or exposure to, a substance. Ordinarily used to denote effects in experimental animals.

Acutely hazardous waste a dangerous material as identified with a dangerous waste number beginning with “P” in WAC 173-303-9903. Contact EH&S at 206-616-5835 for current information.

5 Administrative Details

The Laboratory Safety Manual will be readily accessible at each laboratory at FAU. The LSM can be accessed directly on the **EH&S** web site

6 Basic Safety Practices

There are many excellent publications containing guidelines for the safe conduct of laboratory work; such as Safety in Academic Chemistry Laboratories, published by the American Chemical Society, and Prudent Practices in the Laboratory: Handling and Disposal of Chemicals, published by National Research Council. These publications are concise, readable, and oriented toward academic laboratories. They are recommended reading for all laboratory personnel. Consulting other safety information resources is encouraged, review the references in Appendix D: References or contact the Chemical Hygiene Officer for additional sources.

The following basic safety practices apply to all laboratories[1]. Each laboratory must include any specific practices pertaining to Standard Operating Procedures used in that particular lab (see Appendix A: Standard Operating Procedures).

6.1 Laboratory Contact Information

Each laboratory must have laboratory contact and emergency procedure information posted on the entrance to the lab and by lab telephones, when present. (See Appendix F – Forms and Checklists for recommended form.) Additional laboratory signage is required for work with biological and radiological materials. (See also, Biological Safety and Radiation Safety Manuals.)

6.2 Laboratory Security

When authorized laboratory personnel are not present, each laboratory must be kept locked, even if it is only for a short period of time. Depending on the type of work performed in a particular

[1] Adapted from the National Research Council's, "Prudent Practices in the Laboratory: Handling and Disposal of Chemicals," National Academy Press, Washington, DC, 1995.

laboratory, it may be prudent to keep that laboratory locked at all times. Laboratory personnel must immediately, and politely, engage unknown individuals discovered in a lab in order to determine their reason for being there. A simple, "May I help you?" should get the dialog started. Immediately report suspicious individuals to University Police.

7 General Laboratory Safety Guidelines

7.1 Hazard Awareness

Observe the following basic safety guidelines when working in a laboratory.

7.1.1 Eating, Smoking, etc.

Do not eat, drink, use tobacco products (smoke, chew, dip, vape), chew gum, use cell phones or apply cosmetics in areas where laboratory hazards (eg. chemical, physical, biological, equipment) are present; remove gloves, wash hands and leave the area before conducting these activities. Do not store food or beverages in refrigerators or glassware that have been used for laboratory operations. Food and beverages are not permitted in the laboratories, without regard for the type of hazard(s).

7.1.2 General Housekeeping and Apparel

Keep the work area clean and uncluttered, with hazardous materials and equipment properly labeled and stored; clean up the work area upon completion of an operation or at the end of each day. Confine long hair and loose clothing and remove jewelry. Wear appropriate closed toed shoes at all times in the laboratory. Shorts, open-toed shoes or sandals are not permitted. Wear appropriate PPE where necessary.

Minimum apparel for laboratories includes lab coats or appropriate protective clothing, closed toed shoes, and eye protection. See Section 9 Protective Personal Equipment.

7.1.3 Handling Equipment and Glassware

Handle and store laboratory glassware with care to avoid damage, and never use damaged glassware. Use extra care with Dewar flasks and other evacuated glass apparatus. Shield or wrap them to contain hazardous materials and fragments should an implosion occur. Use equipment only for its designed purpose and based on the manufacturer's instructions. Decontaminate and properly dispose of damaged/unwanted glassware according to any chemical, biological or radiological hazards that may be present.

7.1.4 Sharps

Sharps (needles, blades, broken glass, scalpels etc.) should be disposed of in the designated red plastic sharps box and labeled biomedical waste. Used syringes should be disposed of in a biomedical waste box. Reusable needles should be kept in a wide mouth jar in an area protected from stick injury. New needles should be stored in a secure cabinet.

7.1.5 Unattended Operations

Leave lights on, place an appropriate sign on the door, include your name and telephone number as well as that of Principal Investigator. Provide for containment of toxic substances in the event of failure of a utility service to an unattended operation. All unattended operations must be provided with automatic shutoffs to prevent accidents, fires, or explosions.

7.1.6 Physical hazards

Physical hazards put the lab users at risk of injury. These hazards should be corrected and/or reported when found in the lab. Physical hazards include slips, trips and falls, compressed gasses, pressurized equipment, ergonomic hazards from heavy lifting and repetitive motion, hazardous noise, mechanical hazards, and thermal hazards among others.

7.1.7 Lab Equipment

All lab equipment must be level to prevent samples from spilling. To prevent injury, sharp edges and corners should be protected. Protective guards should be used to cover belts, pulley systems, vacuum pumps, blades and sharp objects when not in use. In the absence of protective guards, the hazardous component should be lowered completely.

7.1.8 Trip and Spill Hazard

Bumpy and loose flooring should be reported to the maintenance department. Electrical and computer cords across walkways should be minimized or eliminated. The use of cord covers may be used where no other option is available. Stairways, aisles and hallways must remain free of obstruction. Shelves should be sturdy and leveled, when possible they should be attached to wall or cabinets.

7.2 Requirements for Storing Chemicals Safely

1. Store like chemicals together and away from incompatible groups of chemicals. Do not store chemicals in alphabetical order. An easy way to store chemicals properly is to use the chemical manufacturer's color-coding system. (i.e. store reds with reds, blues with blues, etc.) Contact EH&S at 7-3129 for assistance, if needed.

2. Flammable materials should be stored in an approved, dedicated, flammable materials storage cabinet or room if the volume exceeds ten (10) gallons.

3. Liquids should be stored in unbreakable or double-contained packaging, or the storage cabinet should have the capacity to hold the contents if the container breaks.

4. Avoid floor chemical storage (even temporary).

5. Chemicals should be stored no higher than eye level and never on the top shelf of a storage unit.

6. Shelf assemblies should be firmly secured to the walls. Avoid island shelves.

7. Each shelf should have an anti-roll lip.

8. Store acids in a dedicated acid cabinet. Nitric acid may be stored there also, if it is kept isolated from the others and away from Acetic Acid.

9. Store severe poisons in a dedicated poison cabinet.

10. All chemicals should be labeled and dated.

11. Look for unusual conditions in chemical storage areas, such as:

    - improper storage of chemicals
    - leaking or deteriorating containers
    - spilled chemicals
    - temperature extremes (too hot or cold in storage area)
    - lack of or low lighting levels
    - blocked exits or aisles
    - doors blocked open, lack of security
    - trash accumulation
    - smoking or open lights or matches
    - fire equipment blocked, broken or missing
    - lack of information or warning signs ("No Smoking", "Flammable Liquids", "Acids", "Corrosives", "Poisons", Chemical Storage")

Any of these conditions should be corrected immediately. Routine inspections of chemical storage areas will prevent accidents.

7.3 Electrical Safety

Only UL approved electrical equipment may be used in the laboratory.

7.3.1 Electrical Cords

The integrity of the cord should be inspected for cracked insulation, broken plugs or any other visible defect. Compromised cords must be removed from service until it is repaired. The use of electrical tape to mend a broken insulation cord is prohibited.

7.3.2 Extension Cords

Extension cords are for temporary use in the lab with portable equipment. Permanent use of extension cords is prohibited. The use of multi plug plugged in a solid surface (wall, table etc.) is acceptable. Only approved heavy duty extension cords and fused power strips are to be used.

7.3.3 Surge Protection

The use of surge protection is recommended for all electrical laboratory equipment. The surge protectors should have internal fuses. Surge protectors should not be plugged into each other in series.

7.4 Avoidance of "Routine" Exposure

Develop and encourage safe work practices. Avoid unnecessary exposure to chemicals by any route and encourage proper personal hygiene (i.e. remove gloves and wash hands prior to leaving laboratory area). Do not smell or taste chemicals. Vent any apparatus that may discharge toxic chemicals (vacuum pumps, distillation columns, ovens, etc.) into local exhaust devices. Inspect gloves and test glove boxes before use. Do not allow release of toxic substances in cold rooms or warm rooms, since these contain recirculated atmospheres

7.5 Working Alone

Avoid working alone in a building. Prior approval from the Principal Investigator is required before working alone in a laboratory as well as informing the University Police upon entering and leaving the building.

Working alone in a laboratory is prohibited when working with a compound of high or unknown toxicity. Working alone in a lab must be approved in writing by the Principal Investigator or Lab Manager.

7.6 Children Prohibited

Minor children (under 18 years of age) are not permitted inside laboratories at FAU unless the minor child is participating in a program of study at FAU and working in the laboratory is required as part of the course, or the minor child is participating in a supervised program officially sponsored by FAU, such as a building tour or field trip. Permission slips/waivers of liability may be required. Refer to the FAU policy on Minors in Research Laboratories or Animal Facilities for additional information. The University's General Counsel may also be contacted for further details.

7.7 Visitors

Visitors must be escorted by lab staff. Prior to entry into the lab, the visitor must be made aware of any potential hazard in the lab. Visitors are subjected to the laboratory regulations of access and control of hazards.

7.8 Laboratory Fieldwork

When conducting fieldwork experiments, personnel (students, staff and/or faculty) must follow the appropriate regulations and guidelines for the project. Conducting fieldwork must be approved in writing by the Principal Investigator or Lab Manager. When working outside of the lab, the PI, supervisor or lab manager should be notified of the plans to be out of the lab and the site location. Individuals should be prepared for various contingencies while in the field. Appropriate PPEs, visible raincoats, an adequate amount of water and bug repellants should be carried along with any surveying tools needed for conducting the project.

7.9 Working with Animals

See Animal Research Health and Safety Plan.

8 Emergency Procedures

8.1 Natural Disaster and Severe Weather

Each laboratory must prepare an emergency plan and all personnel should be familiar with it. The emergency plan should include the appropriate precautions to be taken to protect laboratory equipment, data, research, animals, chemicals and hazardous materials that will minimize the impact of hazardous conditions resulting from utility failures or loss, fire, flooding or severe weather. The *FAU Laboratory Disaster Preparedness Checklist* can be used in preparing your lab for emergencies.

The PI/Lab Manager should train all lab personnel on the contingency plan. This plan should be shared with building manager to be included in the Building Emergency Plan. The plan should be implemented whenever a severe weather event has been issued by the FAU Department of Emergency Management.

8.2 Medical Emergencies

Medical emergencies involving accidents, spills or fires involving injuries requiring urgent medical attention, immediately call 9-1-1 and/or the Campus Police to speak with a police dispatcher. Initiate life saving measures as needed until the medical response team arrives. Do not move any injured person unless it is absolutely necessary.

8.2.1 First Aid

For minor cuts, burns, chemical splashes or bleeding, provide on-site first aid treatment using the first aid kit, safety shower and/or the safety eyewash.

Chemical splashes, *over a large area of the body*, while under the safety shower, immediately remove the contaminated clothing. Flood the exposed areas for a minimum of 15 minutes. Repeat the flooding with water if any pains resume. A light detergent can be used to wash off chemicals. Do not use neutralizing soaps or salves.

***On a confined area of the skin*,** flush the affected area with cold water and use a mild detergent to remove the chemicals. Remove any jewelry from the affected area immediately. For delayed chemical reactions e.g. Phenols, hydrofluoric acid, ethyl and methyl bromides seek medical attention immediately.

Hydrofluoric Burns, flush the affected area with water for 2 – 5 minutes then apply calcium gluconate or a 10% $^{W}/_{V}$ calcium gluconate solution to the affected area and seek medical attention. Application of the calcium gluconate antidote is imperative to minimize the risk of serious, lasting injury or fatality. On arrival, inform emergency medical personnel that a hydrofluoric acid exposure has occurred.

Phenols, are easily absorbed

For the eye(s), holding the eye open, wash the inner surface of the eyelid and the eye with water for a minimum of 15 minutes. Remove contact lenses if possible. As soon as flushing begins, contact emergency medical personnel who can provide further evaluation, assistance and treatment to avoid lasting eye injury and/or blindness.

***Cryogen or dry ice burns (frostbite)*,** flush the affected are with tepid water. Do not use hot water. Seek medical treatment.

Inhalation of Chemical Fumes, Move to fresh air and seek medical attention. In the event patient is overcome, evaluate the area for your own personal safety prior to attempting to retrieve the victim. Do NOT attempt a rescue in an unsafe atmosphere without proper PPE and emergency response training. Well-intentioned rescuers have often become a victim as well in these situations.

Ingestion of a toxin, Consult Safety Data Sheet (SDS) and call the Poison Control Information Center at 1-800-222-1222 for emergency response information for the specific compound ingested. Seek medical attention immediately. The (M)SDS should accompany the patient to the medical treatment facility.

8.3 Clean-up

Promptly clean up all small spills using appropriate personal protective equipment and properly containerize and label the resulting waste. Contact EH&S for pick up and disposal. Consult the SDS and other safety information sources for specific clean-up recommendations. Contact EH&S to clean up large chemical spills or spills of highly toxic chemicals. For detailed information on procedures for accidents, spills and emergencies see Appendix E.

8.4 Chemical Spills

Only small spills that constitute of a minimum hazard can be cleaned up by laboratory staff. Large spills will be handled by the EH &S and FAU PD.

8.4.1 Incidental Chemical Spills

Alert personnel in the immediate area. Turn off ignition sources in the immediate are. Avoid breathing in the vapors. Wearing the appropriate PPEs (safety goggle, disposable gloves, shoe covers, long sleeve lab coat etc.), use a commercial kit or the materials found in Appendix E to clean up the spill. Contain the spill by diking the perimeter first then gradually move towards the center of the spill.
Dispose of the absorbent in an appropriate container and label it with a Hazardous Waste label. Clean are with water.

8.4.2 Mercury Spills

For Mercury spills refer to Appendix E.

8.4.3 Large Chemical Spill/Release

Identify the spelled material and avoid breathing in the vapors. Turn off all sources of ignition. Immediately evacuate the area and close the doors. If an individual has been splashed with chemicals refer to First Aid – Chemical Splashes section for more information. Contact EH&S and FAU PD to evaluate and control the affected area. On all doors granting access to the affected are, place signs advising personnel not to enter the lab.

8.5 Fires

Fire Safety Training for Laboratory Employees Fires and explosion are the most serious physical hazards faced in typical chemistry labs as well as in other labs and research and experiment settings. The concentration of fuel loads in the form of flammable and combustible liquids as well as the existence of highly pressurized cylinders of various kinds: together with different kinds of ignition sources that are used for operation classify laboratories to be high hazard areas to work. Training will outline how to prevent fire in lab setting which will outline on the handling of flammable and combustible liquids including hazardous waste materials (fuel loads) containment of ignition sources be electrical, chemical, or mechanical. It also addresses the proper procedures to follow for preparing for a fire emergency and what to do should a fire emergency occur. A hands-on fire extinguisher training and knowing the different types of fire extinguisher is also an important part of the training module. Lab supervisors, technicians, student and faculty members who teach and work in labs participate in this training. (See Fire Safety Manual).

8.6 Reporting

Should an accident occur, follow procedures outlined in Appendix E: Hazardous Materials Emergencies and Spills. Report all accidents to your supervisor. Notify **EH&S 561-297-3129** or ehs@fau.com

8.7 Follow-up Investigations

EH&S will follow-up all investigations for exposures and injuries.

9 Personal Protective Equipment

The laboratory environment contains many potential hazards. Most hazards can be reduced or eliminated by substitution and/or engineering controls. Substitution is the reduction or elimination of a hazard by replacing a high hazard material or procedure with a less hazardous one. When hazards cannot be adequately controlled through the use of substitution and/or the implementation of engineering controls, personal protective equipment (PPE) may be required.

PPE issued to laboratory personnel must be appropriate for the task and will depend upon the proper hazard identification and assessment made by the Principal Investigator (PI). Laboratory personnel must understand the use and limitations of the PPE. PPE includes, but is not limited to, laboratory coats and aprons, eye protection (safety glasses, face shields, etc.), and gloves. Laboratory personnel must wear proper PPE when it is required.

9.1 Eye/Face Protection

The PI has many responsibilities in regard to eye and face protection, including:

a. Assessing the potential for eye/face injuries due to exposure to eye or face hazards from flying particles, molten metal, chemicals, biological materials, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation
b. Training employees on the uses and limitations of PPE
c. Providing the appropriate type of protection required

d. Ensuring that the appropriate eye/face PPE is available and used by laboratory personnel.
e. All eye/face protection devices must meet the requirements set forth in the ANSI Z87 standard. Note: Additional eye/face protection standards should be consulted for welding operations (29 CFR 1910.133(a)(5)) and for laser use (ANSI Z136).

When evaluating the appropriate type of eye protection to use, it is important to note that more than one type of protection may be appropriate. Also, multiple layers of eye and face protection may be warranted for higher-hazard operations. During the PPE selection process, the PI should consider the following:

a. Safety glasses should be upgraded to splash-resistant chemical goggles whenever pouring liquid chemicals. Chemical goggles offer a much higher degree of eye protection.

b. Face shields are not to be worn alone. They must only be used as a secondary means of eye and face protection, with the appropriate primary eye protection worn underneath. For example, chemical goggles should be worn under a face shield while pouring acids.

c. Goggles come in many varieties. The right type of goggle must be selected to ensure the appropriate level of eye protection is achieved. For example, vented goggles protect the wearer from flying chips and are appropriate for cutting operations; however, the vents make them less effective as splash protection.

Contact **EH&S** for additional information on the assessment of hazards, and the selection, and use of eye/face protection equipment.

9.2 Gloves

Gloves play an important role in the safe handling of laboratory materials. Gloves must be comfortable, sufficient in length, and made of material that has the appropriate level of chemical resistance for the task to provide adequate protection. Depending on its intended use, a glove may be designed to provide dexterity, strength, low permeability, resistance to penetration by sharp objects, or protection from temperature changes. Specific information on the properties of glove materials can be found in the manufacturer's permeation guide. See Appendix C: Glove Selection Chart for additional information.

9.3 Respirators

The selection and use of respirators must be done in accordance with 29 CFR§1910.134 and FAU's Respiratory Protection Policy. Respirators can only be used when it is not possible to minimize or eliminate exposure to a contaminant through other means. All individuals issued respirators must meet the criteria established in the OSHA standard and University Policy. These criteria include medical screening, training and fit testing. For further information, contact **EH&S.**

9.4 Lab Coats & Aprons

9.4.1 General

The following general directions apply to both disposable and reusable lab coats and aprons, used for chemical, biological, and/or radiological protection. All laboratory clothing shall be stored in a sanitary manner in a contamination-free area of the lab. Lab coats and aprons are not to be worn while eating or drinking, and should not be worn outside the laboratory except when transporting hazardous materials or moving between labs. The wearing of lab coats, aprons, or other potentially-contaminated personal protective equipment into break areas or lunch rooms is strictly prohibited.

Lab coats and aprons that are contaminated must be handled as little as possible. They must be evaluated by laboratory personnel for laundering or disposal, depending on the nature of the contamination, and bagged or containerized at the location of use. If coats or aprons are visibly wet, they should also be placed in secondary containment to prevent the spread of contamination should the plastic bag or container leak or be otherwise compromised during storage or transport. Lab coats and aprons must not be sorted or rinsed in the location of use since the process can result in the spread of contamination and/or the uncontrolled release of contaminants down the drain. Note: Rinsing areas in labs may also be unsanitary or inadequate for laundering purposes.

9.4.2 Disposable Lab Coats and Aprons

Use of disposable lab coats and aprons whenever practical is strongly encouraged as these coats are low-cost and can be replaced once contaminated or otherwise soiled. Disposable, single-use coats and aprons can be placed in the trash if they have not been contaminated with chemicals, pathogens, or radionuclides.

If contaminated, lab coats and aprons shall be placed in a sealed, leak-proof, labeled plastic bag and segregated by contaminant type – chemical, radiological, or biological. Contact EH&S for pickup and disposal of contaminated, disposable lab coats, as you would with any other hazardous waste. Note: Disposable lab coats and aprons shall not be cleaned since the cleaning process can severely degrade the materials of construction, potentially allowing contamination to pass through onto clothing on reuse.

9.4.3 Reusable Lab Coats and Aprons Contaminated with Chemicals

Lab coats and aprons that become contaminated with chemicals must be evaluated on a case-by-case basis. Those that are contaminated with acutely hazardous chemicals or waste shall be considered hazardous waste and must not be laundered or reused. Lab coats and aprons that have been grossly contaminated with non-acutely hazardous waste may also be designated for disposal rather than laundering, depending on the chemical nature of the contaminant(s), since laundering may spread contamination and/or result in discharge of effluent that exceeds local limits. All lab coats and aprons that are designated for management as hazardous waste shall be placed in a sealed, leak-proof, labeled plastic bag, placed in the lab's waste storage area, and picked up by EH&S.

Lab coats and aprons that have been contaminated due to incidental contact with non-acutely hazardous chemicals or that have become dirty from regular use can be laundered by a commercial vendor that has expertise in cleaning lab coats, or laundered onsite at an approved facility per the Onsite Lab Coat and Apron Laundering procedures provided at the end of this section. Note: When a department's contaminated laundry is transported off site; the department must ensure compliance with all applicable federal, state, and municipal regulations, including labeling.

FR (Flame Resistant or Flame Retardant) Lab coats must be worn when handling Pyrophoric or extremely flammable (flashpoint <73°F) substances. These Lab coats must be cleaned by a qualified commercial vendor in order to retain the FR properties.

9.4.4 Reusable Lab Coats and Aprons Contaminated with Pathogens

Universal Precautions should be observed for all lab coats and aprons that are contaminated or potentially-contaminated with pathogens. Contaminated lab coats and aprons can be disposed of as biological waste; sent to a commercial vendor that has expertise in cleaning lab coats; or autoclaved, evaluated for reuse, and laundered onsite. Note: Depending on the materials of construction, the coat or apron may not be able to withstand the high temperatures of an autoclave. Also, coats or aprons that also have chemical or radiological contamination should never be autoclaved.

All lab coats and aprons that are designated for management as biological waste shall be placed in a sealed, leak-proof, labeled plastic biological waste bag, placed in the lab's waste storage area, and picked up by EH&S.

When staging contaminated lab coats or aprons for pickup by an outside commercial laundering service, the use of alternatively labeled or color-coded containers is required. Employees must be able to readily recognize the containers as requiring compliance with Universal Precautions. Departments must ensure that employees are provided with proper, color-coded containers that are designated for exclusive use in the transport of contaminated laundry. As with the case of chemicals, when a department's contaminated laundry is transported off site; the department must ensure compliance with all applicable federal, state, and municipal regulations, including labeling.

Biological laboratory lab coats and aprons that are dirty from regular use but otherwise uncontaminated, or those that have undergone successful autoclaving can be laundered at an approved on site facility per the Onsite Lab Coat and Apron Laundering procedures provided at the end of this section.

9.4.5 Reusable Lab Coats and Aprons Contaminated with Radionuclides

As with the case of chemicals, lab coats and aprons that become contaminated with radionuclides must be evaluated on a case-by-case basis. Lab coats and aprons that become contaminated with long-lived radioisotopes (^{3}H, ^{14}C, ^{22}Na, ^{51}Cr, ^{45}Ca) shall be placed in designated, dry solids, radioactive waste containers for management as radioactive waste. Lab coats and aprons contaminated with short-lived radioisotopes (^{32}P, ^{33}P, ^{35}S, ^{125}I) shall be segregated from other radioactive waste. Contact the Radiation Safety Officer (561-297-3129) for storage of these items in designated, separate, radioactive material containers where the lab coats will be kept until the radioisotopes have been fully decayed. Once fully decayed, the lab coats can be removed and evaluated for reuse. Note: Never autoclave lab coats that are contaminated or potentially contaminated with radioactive material.

Lab coats and aprons from a laboratory that uses radioactive materials that are not contaminated, including those that have been fully decayed, surveyed, cleared and deemed reusable may be laundered by a commercial service with expertise in laundering laboratory clothing or at an approved onsite laundry facility per the Onsite Lab Coat and Apron Laundering procedures provided at the end of this section.

9.4.6 Onsite Lab Coat and Apron Laundering

Departments and/or laboratories that have their own laundering facilities must ensure that the use of these facilities does not (1) result in the spread of contamination, (2) result in the uncontrolled release of chemical, biological, or radiological contamination to the environment while lab coats or aprons are being transported, or (3) send contamination down the drain that exceeds the City of Boca Raton's wastewater treatment facility influent limitations. Refer to the City of Boca Raton Sewer Use Policy Limits provided in Hazardous Materials Manual, and contact EH&S for additional information or clarification.

10 Laboratory Equipment

Each equipment will have its own set of specific safety requirements. Below is a generalized list of guidelines to follow when using laboratory equipment.

a. Repairs are to be performed by overseen by a certified technician
b. The recommended maintenance procedures outlined in the manual are to be followed and logged.
c. All Equipment must be grounded
d. Operators should be trained by qualified lab personnel prior to use.
e. Never remove hazard warnings or identification labels from the instrument
f. Always keep the manufacturers manual with the instrument or easily accessible in a nearby vicinity.
g. Use the manufacturers recommended PPE when operating the instrument

10.1 Centrifuges

The centrifuge must be balance prior to use to prevent damage to the instrument or injury to the user. If any noises or vibration is observed, the centrifuge is to be stopped immediately. An instrument log should be kept detailing the use of the rotors and centrifuges.

10.2 Refrigerators, Freezers and Cold Rooms

Refrigeration units should not be modified or repaired by laboratory staff.

10.3 Labeling

All ovens, microwaves, freezers, refrigerators and cold room must be labeled to indicate the use i.e. biological material, flammable liquids, chemicals only, etc. The range of operation should be placed on the front of the door.

10.4 Flammable Storage Units

Flammable liquids should be stored in suitable refrigerators or freezers per the manufactures label.

10.5 Explosion Proof Units

Explosion proof units are required where the rooms or area have potentially explosive atmosphere. Explosion proof freezers or refrigerators are required for highly explosive chemicals. Currently, FAU has no facility that requires an explosion proof unit, freezer or refrigerator.

10.6 Heating Equipment

Whenever possible, steam heating devices should be used instead of Bunsen Burners or electrically heated devices. Spark and shock hazards are eliminated with the use of steam heated devices.

10.7 Gas Burners

The use of an open flame burner (i.e. Bunsen Burner or "burner") is permissible under specific conditions in rooms designated for laboratory use settings when solely used for teaching and research purposes under the PI or designee's supervision. Below is a generalized list of requirements to follow when using laboratory open flame equipment.

(a) The heat should be distributed with a wire gauze pad (where applicable).
(b) Prior to use, the tubing should be checked for cracks, holes, pinch points or other defects. Items are observed to be damaged, the burner shall not be used and is to be removed from use until repaired or replaced.
(c) The tubing attachment should be secured with clamps.
(d) Burner(s) shall be located at least 12 inches (30 cm) away from any overhead shelving, equipment or light fixtures.
(e) All combustible materials and chemicals shall be removed from within a 2 ft radius around the burner location.
(f) Reference section 7.1.2 for the appropriate apparel. Verify lab coats or gowns, are flame resistant.
(g) Notify others in the laboratory that the burner will be in use.

(h) A sparker/lighter with extended nozzle shall be used to light the burner.
(i) Open flames or operating burners shall not be left unattended for any amount of time.
(j) Ensure that the main gas valve is off when the burner is not in use.
(k) Compressed gas cylinders used as a fuel source for portable burners shall not exceed Lecture size (approximately 5 cm x 30 cm or 1 Lb. or 0.4 L or 0.5 kg).

(l) A maximum number of two 1 Lb. or equivalent flammable cylinders can be stored in the laboratory in the fume hood. Excess compressed gas cylinders not in use must be stored outside of the laboratory with any associated regulators removed.

(m) All compressed gas cylinders must be properly labeled. Re-label the bottle if the label becomes illegible or falls off.

(n) Only use the manufacturer recommended regulator, pressure relief, tubing and valves with the compressed gas cylinder.

10.8 Electrical Heating Devices

Only UL approved electrical equipment should be used. Hot plates must have a heating element enclosed in a ceramic, insulated or glass case.

Oil baths should be monitored using a thermometer or equivalent device to ensure the oil does not exceed its flash point. Safety measure to be taken to prevent the possibility that the volatile substance or water could contaminate the hot bath.

Heating mantles should be checked for broken insulation and that no chemical or water has contaminated the mantle prior to each use. When using the variable transformer be careful not to exceed the recommended mantles manufacturers input voltage.

Space heaters are a prohibited fire safety hazards. Reference the Fire Safety Manual, 11.3.2 Policy on Electrical Equipment and Appliances. http://www.fau.edu/ehs/info/fire-safety-manaul.pdf

10.9 Cooling Equipment

A self-contained cooling system should be used in a cooling experiment. Do not use running tap water for more than 30 minutes for any cooling experiment or reagent preparation.

10.10 Glassware and Hoses

Glassware and hoses should be handled with care to avoid damage. Damaged items should be discarded or repaired (if applicable).

Before use, glassware must be inspected for chemical residue, cracks, chips or breaks. Before use, connectors and tubing must be inspected for splitting and cracks.

Glassware must be washed properly using the lab specific cleaning SOP.

10.11 Vacuum Systems

Vacuum systems should be used solely to pull a vacuum on an equipment. Vacuum systems should have a secondary trap. When flammable vapors are extracted by the vacuum, cold traps should be used. To prevent solvent loss, it is recommended that in-line flow restrictors should be used. When aspirating liquids, a hydrophobic in-line filter should be used between the vacuum port and the collection vessel in the apparatus setup. This minimizes contamination and degradation of the vacuum system.

10.12 Fume Hoods

See Local Exhaust

10.13 Disposal of Used Equipment

Laboratory equipment used with radioactive, chemical or biological substances must be decontaminated prior to storage or disposal. The PI will be responsible for the denomination of the equipment. The equipment should be drained of all liquids and oils and disinfected with the appropriate reagent. The PI will be responsible for contacting EH&S (ehs@fau.edu) and Property Management (property@fau.edu). For the disposal of surplus equipment see FAU Property Policy

11 Waste Disposal

Standard Operating Procedures (see Appendix A) for each laboratory must include procedures for waste disposal. Each laboratory generating hazardous waste must have at least one lab manager responsible for ensuring that all waste generators within the lab receive annual Hazardous Waste Awareness and Handling Training. Hazardous wastes must be properly containerized, labeled and stored. Contact EH&S for pick up and disposal of hazardous wastes. Hazardous Waste Disposal Procedures for the University are outlined in the **Hazardous Materials Manual**.

12 Exposure Control Measures

Safe work with hazardous chemicals can only be accomplished by using proper control measures. Proper control measures include the use of engineering controls, appropriate storage and handling of chemicals, the use of personal protective equipment, and proper use and maintenance of safety equipment. Carefully implemented control measures can reduce or eliminate the risk of employee exposure to hazardous chemicals.

12.1 Engineering Controls

Engineering controls include proper laboratory design, adequate ventilation, and the use of other safety devices (mechanical pipettes, safety centrifuge cups, etc.). Ventilation is the most common and most important form of engineering control used to reduce exposures to hazardous chemicals. There are two types of ventilation: general ventilation, and local exhaust.

12.2 General Ventilation

General ventilation for laboratory operations should be designed such that the laboratory is under a slightly negative pressure relative to other parts of the building. This prevents odors and vapors from leaving the lab. Lab ventilation should be verified by professional engineering analysis. Proper design of laboratory ventilation systems minimizes the possibility of chemical vapors accumulating.

12.2.1 Local Exhaust

Local exhaust ventilation systems are intended to capture an emitted contaminant at or near its source, before the contaminant can disperse into the workplace air. In laboratories, chemical fume hoods are local exhaust devices recommended for use to reduce exposure to hazardous dusts, fumes and vapors. As a rule, the hood shall be used for all hazardous procedures involving substances that are hazardous/toxic, volatile and/or have a PEL less than 50 ppm. The hood sash should be closed or lowered to an appropriate working level to provide protection from chemical splashes and fires and to allow for optimal hood operating efficiency.

Fume hoods are certified annually for proper operation by EH&S. A sticker located above the sash contains the proper sash height, hood face velocity (generally recommended to fall within 100 – 140 linear feet per minute of air), date of inspection and the inspector’s initials. The proper sash height is also indicated by a sticker on the side of the fume hood opening. If there are problems with a hood, the Utilities Department and EH&S should be notified. A hood is not designed to withstand explosions nor as a means of disposal for volatile chemicals. When using a fume hood, always keep your work at least 6 inches inside the hood face. This simple step can reduce vapor concentrations at the face of the hood by as much as 90 percent. See the section entitled Fume Hood Performance for more on hood usage.

Biological safety cabinets, glove boxes, and isolation rooms also provide local exhaust ventilation. These are usually very specialized pieces of equipment. Biological safety cabinets must be certified for use annually by trained and certified individuals such as manufacturer or distributor representatives. Glove boxes should be pressure tested periodically to ensure they are functioning properly.

12.3 Proper Storage and Handling of Chemicals and Hazardous Materials

Proper storage of chemicals and hazardous materials is important to prevent chemical reactions that may result in fires, explosions or other safety/health hazards. Chemicals must be stored according to their chemical group, not simple alphabetical order. Store chemicals of similar hazards and reactivity together. Many chemical companies provide storage codes for their products in order to assist customers with the proper storage of chemicals. Here are some general rules for safe chemical storage:

a. Store chemicals and hazardous materials only in secure, well-ventilated areas.

b. Chemical and hazardous materials waste should be stored in the designated accumulation area, in appropriate containers and labelled properly. Reference Labeling

c. Chemicals and hazardous materials should be stored properly in cabinets or on shelves. Do not store chemicals on the floor or in fume hoods. Make sure all chemicals are securely capped when not in immediate use.

d. Shelving units must be stable and secured to the wall (island units must be braced across the top). Shelves should have lips to prevent items from sliding off.

e. Keep chemicals pushed back on shelves to prevent them from falling off in the event of accidental tipping. A good rule of thumb is to set bottles back from the edge a distance equal to the height of the bottle when in an upright position.

f. Reactive chemicals should be stored on low shelving, preferably in secondary containment in case of leakage.

g. Dispose of outdated chemicals. Contact **EH&S** at ehs@fau.edu to dispose of outdated chemicals.

h. Always keep chemicals properly labeled – relabel if a label is becoming faded or has been damaged.

i. Make sure labels include the full name of the chemical, clearly written out in English and the proper GHS Pictograms. Do not use abbreviations, acronyms, chemical formulas, and chemical structural diagrams as the sole source of information on container labels.

j. Store large quantities of flammable chemicals in an approved flammable storage cabinet.

Laboratory personnel must always wear proper PPE when handling hazardous materials, chemicals, and secondary containment must always be used when transporting chemicals and hazardous materials from one location to another to prevent accidental chemical releases.

12.3.1 Solid or Powdered Chemicals

Powdered metals should be stored as directed by the SDS or the manufacturer's instructions on the bottle.

Solid Chemicals must be stored alphabetically on shelves. Cyanide compounds must not be stored near acids. Cross contamination may release cyanide gas. Phenol crystals must be stored away from oxidizers.

12.3.2 Liquid Chemicals

All liquid chemicals must be segregated by their respective hazard classification and stored only with compatible chemicals.

12.3.3 Flammable Chemical Storage

Flammable liquids generate vapors that can readily ignite and burn in air. The rate at which different liquids produce flammable vapors depends on their vapor pressures and temperatures. These substances should be stored separately from oxidizers and corrosive materials and in a flammable storage cabinet. Storage of flammable liquids (including waste) outside approved flammable storage cabinets and safety cans must not exceed 10 gallons per 100 square feet of laboratory space. See *Table I* for storage limitations imposed by OSHA and NFPA.

Table I Flammable and Combustible Liquid Storage Limits for Laboratories[1]

Laboratory Unit Class	Flammable or Combustible Liquid Class	Excluding Quantities in Storage Cabinet[2] or Safety Cans	Including Quantities in Storage Cabinets[3] or Safety Cans
		Maximum Quantity[3] per 100 sq.ft of Laboratory unit	Maximum Quantity[3] per 100 sq.ft of Laboratory Unit
A[4] (High Hazard)	I	10 gallons	20 gallons
	I, II and IIIA	20 gallons	40 gallons
B (Intermediate Hazard)	I	5 gallons	10 gallons
	I, II, IIIA	10 gallons	20 gallons
C (Low Hazard)	I	2 gallons	4 gallons
	I, II, IIIA	4 gallons	8 gallons

[1]The information in this table was taken from the NFPA 45 standard on *Fire Protection for Laboratories Using Chemicals,* 1996.
[2]Only *Approved Storage Cabinets* as defined by NFPA 45 are allowed by **EH&S**.
[3]The maximum quantities of flammable and combustible liquids in Class B and Class C instructional laboratory units shall be 50 percent of those listed.
[4]Class A laboratory units shall not be used as instructional laboratory units.

12.3.4 Corrosive Liquid Storage

Corrosive chemicals include strong acids and bases, dehydrating agents, and oxidizing agents. Inhalation of vapors or mists from these substances can cause severe bronchial irritation. These chemicals also erode the skin and respiratory epithelium and are particularly damaging to the eyes.

Corrosive chemicals should be stored in corrosion resistant cabinets, and separated from other reagents. Acids should be stored separately from bases and both should be stored separately from flammables and combustibles. Acids and bases should be stored away from metals and oxidizing agents in a cool and well-ventilated area. Secondary containers such as bottle carriers or chemical resistant tubs to isolate the reagent bottle. The storage area should be checked regularly for leaks and spills. Bottle cap should be secured on the bottles with the exception of reagents or mixtures that generate gases during storage. These exceptions should be stored in well vented cabinets or fume hoods. If splashed with an acid or base follow the first aid emergency procedures. Always pour acids into water, NEVER the reverse.

a. **Nitric acid** should be stored by itself away from other chemicals whenever possible. Never store Nitric acid with organic acids (i.e. Glacial Acetic Acid). Nitric Acid is very corrosive and its oxides are highly toxic. Nitric acid is an oxidizing agent, it may form explosive and flammable compounds with several materials e.g. Acetone, combustible materials, ethers. Nitric acid should be used in fume hoods away from combustible substances. Paper towels should never be used to clean up nitric acid spills. The paper towel may ignite spontaneously.
b. **Chromic acid** should be used with extreme care if there are no other alternatives. Additionally, chromic acid solutions are expensive to dispose of. If being used as a cleaning solution for glassware, it is recommended it is replaced with non-chromic acid compounds e.g. No-Chromix.
c. **Perchloric Acid** may form potentially highly explosive and unstable compounds in the presence of metals and/or organic compounds. Perchloric acid should be used in fume hoods designated solely for its use. The perchlorate crystals may get trapped in the fume hood ductwork and potentially may cause a fire. These fume hoods have corrosion resistant ductwork and wash down facilities which should be cleaned before and after each use. Only minimum quantities of Perchloric acid should be stored in any lab. The date received and opened should be written on the storage container. After one year, it should be disposed of as explosive crystals may have formed.
d. **Hydrofluoric acid (HF)** weakens glass and is extremely corrosive. Effects of HF burns are delayed and may not be felt immediately. The effects are very painful and may heal very slowly. The mists or vapors of HF when inhaled, may cause severe damage to the respiratory system that could result in death. HF must be used in a suitable fume hood with the proper PPE (safety glasses, lab coat, gloves etc.). HF should always be stored in high or low density polyethylene or Teflon containers. If exposed to HF follow the first aid emergency procedures.
e. **Picric acid** especially when dry can form explosive compounds with many combustible materials. With a moisture content of 10% or less, picric acid becomes unstable and may explode with handling such as sudden temperature changes, light shaking, or friction created by the opening of the cap. Picric acid should be store in minimum quantities for a short period of time not to exceed 1 year.

12.3.4.1 Oxidizing Agents

Oxidizing agents, in addition to their corrosive properties, can present fire and explosion hazards on contact with organic compounds or other oxidizable substances. Strong oxidizing agents (see

Table II) should be stored and used in glass or other inert containers. Cork and rubber stoppers should not be used with these substances.

Table II Examples of Oxidizing Agents[1]

Gases:	Fluorine, Chlorine, Ozone, Nitrous Oxide
Liquids:	Hydrogen Peroxide, Nitric Acid, Perchloric Acid, Bromine, Sulfuric Acid
Solids:	Nitrites, Nitrates, Perchlorates, Peroxides, Chromates, Dichromates, Picrates, Permanganates, Hypochlorites, Bromates, Iodates, Chlorites, Chlorates

[1]The information in this table was taken from *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals.* National Academy Press 1995.

12.3.5 Highly Reactive (Shock Sensitive) Chemicals

Highly reactive chemicals are inherently unstable and can react in an uncontrolled manner liberating heat and toxic gases, which can lead to explosion. These include shock sensitive chemicals, high-energy oxidizers, and peroxide formers. Before using these materials, safety information should be reviewed to evaluate proper storage and handling procedures. Always date highly reactive/shock sensitive chemicals upon receipt and upon opening.

The following additional procedures are recommended for handling reactive chemicals:

a. Secure reaction equipment properly.

b. Use impact protection (shields and guards) in addition to chemical splash protection (eye protection, gloves, laboratory coat, etc.).

c. Handle shock-sensitive chemicals gently to avoid friction, grinding, and impact.

Review Section 7.2 for specific examples of shock sensitive chemicals as well as additional safety information.

12.3.5.1 Peroxidizable Compounds

Peroxidizable compounds (including ethers) are a group of chemicals which become shock sensitive when they form organic peroxides. This reaction is catalyzed by changes in sunlight, temperature, and pressure. Store these compounds airtight and in their original containers, ideally with an inert gas such as nitrogen in the headspace (the area above the liquid in the bottle). Isolate these chemicals from combustible and oxidizable materials, preferably in a flammable storage cabinet. Always date peroxidizable compounds upon receipt and upon opening. See Appendix B and the FAU PEC Guidelines for more information on the handling, disposal, labeling and storage time limits for peroxidizable compounds.

12.3.6 Dehydrating Agents

Dehydrating agents should be added to water, NEVER the reverse to avoid splattering and violent reactions. Due to their affinity for water, dehydrating agents cause sever burn on contact with the skin. Dehydrating agents include calcium oxide, sulfuric acid, phosphorus pentoxide and sodium hydroxide.

12.3.7 Dark Rooms

The chemicals found in dark rooms are toxic and corrosive. Spent fixers must be routed through a silver cartridge to ensure the silver (heavy metal) does not go down the drain.

12.3.8 Toxic Chemical Storage

Toxic chemicals should be stored in accordance with general chemical compatibility guidelines. Highly toxic chemicals that can pose immediate danger to life and health upon container opening should be stored under lock-and-key. Some examples of these compounds include, but are not limited to, dimethyl mercury ($(CH_3)_2Hg$), thallium (III) oxide (Tl_2O_3), and hydrofluoric acid (HF).

12.3.9 Cryogenic Liquids

Exposure to cryogenic liquids and the gases they release may cause frostbites, asphyxiation caused by oxygen displacement and potential fires. The storage of cryogenic liquids such as nitrogen and helium are subject to the following safety requirements. Other cryogenic liquid such as liquid oxygen hydrogen etc. Further precautions found in their specific (M)SDS are required.

a. The proper PPE should be worn, including a face shield.
b. Long pants, long sleeves and full coverage shoes should be worn
c. Thermal gloves with tightly fitted cuffs should be worn.
d. The dispensing of cryogenic liquids should be done in a well-ventilated area to limit the exposure to its gases which may cause asphyxiation.
e. If splashed remove the affected clothing and follow the first aid procedures.
f. Do not transport cryogenic liquids in a closed vehicle. They should be secured to a cart or open bed.
g. Non-insulated pipers containing cryogenic liquid should be kept away from combustible materials to minimize potential fire hazards.
h. If the container or dear ruptures or releases, vacate the area immediately and notify EH&S immediately.
i. On Dewar’s, a pressure relief valve should be installed to avoid quick and violent pressure changes when the cryogens vaporize.

12.3.10 Mercury

Mercury is highly toxic and must be stored in containers with the ability to withstand it weight. This container must be stored in a secondary container. Mercury should be stored on the lowest shelf available. Where possible, mercury should be eliminated from the lab. The use of non-mercury thermometers are highly recommended.
For Mercury spills refer to Appendix E.

12.3.11 Metals

12.3.11.1 Metal powders

Metal powders dust and metal powders subject to rapid oxidation may create an explosive hazard when airborne in the presence of an ignition source. Metal powders may ignite when in contact with acids.

12.3.11.2 Alkali Metals

Alkali metals can ignite spontaneously in air, especially in the presence of high humidity or the metal is in powder form. Alkali metals should be stored under kerosene or mineral oil. Special Class D dry powder fire extinguishers only should be used to put out alkali metal fires. Contact **EH&S** if your lab requires a Class D Dry Powder Fire Extinguisher. Alkali Metal wastes should be stored under mineral oil in a in a leak proof container.

12.3.12 Crossover Properties

Many chemicals found in the laboratory exhibit properties common to more than one of the previously mentioned groups (for example, ether). For each chemical, one should simultaneously follow the safety guidelines for all applicable hazard groups. Contact **EH&S** for additional information about the storage of specific chemicals.

12.3.13 Storage of Chemicals in Refrigerators

All refrigerators located in laboratory areas must be clearly marked as to their contents. An inventory list should be posted on the outside of the refrigerator. Refrigerators used for chemical storage must be marked "Chemical Storage Only! No Food!" Flammable chemicals are not to be stored in a refrigerator unless the refrigerator is specifically designed and approved for flammable storage. Refrigerators located in break rooms or lunchrooms, and which are located in the vicinity of laboratories, should be marked "Food Storage Only! No Chemicals!" *Refrigerators in laboratory work areas must not be used for food storage.*

12.3.14 Labeling

All containers (including beakers, vials, flasks, etc.) must be labeled with their chemical content(s) and other relevant information. This includes diluents as well as stock solutions. Whenever possible, chemicals should remain in their original containers with the original labels intact. If a chemical is transferred from its original container to a new container, the new container must have the full name of the chemical, written out in English, and the appropriate GHS Pictogram. Damaged or faded labels must be replaced before becoming illegible. Additional information on labeling requirements can be found in the FAU Hazard Communication Program Manual.

12.4 Compressed Gas Cylinders

Compressed gas cylinders may present both physical and health hazards. Gases may be oxidizers, flammable, reactive, corrosive, or toxic and these properties must be considered when developing experimental procedures and designing apparatus. Compressed gases, when handled incorrectly, can be very dangerous with a high potential for explosion. Only cylinders designed, constructed, tested, and maintained in accordance with US Department of Transpiration (DOT) specifications and regulations shall be permitted to be used. The use of non-DOT conforming cylinders must be evaluated and approved by EH&S on a case-by-case basis.

OSHA's general requirements for compressed gas cylinders can be found in 29 CFR 1910.101, which incorporates by reference the Compressed Gas Association's Pamphlets C-6-1968, C-8-1962, and P-11965. These pamphlets describe the procedures for inspecting, handling, storing, and using compressed gas cylinders. The National Fire Protection Association also provides guidance on the management of cylinders in NFPA 55: Compressed Gases and Cryogenic Fluids Code, which is incorporated by reference into the Uniform Fire Code. Safety procedures that must be followed when handling, storing, and transporting compressed gas cylinders are summarized below:

a. Cylinders must be clearly labeled with their contents.

b. Cylinders and cylinder storage areas must display the NFPA 704 signage.

c. Regulators must be compatible with the cylinder contents and valve.

d. Cylinders must be secured in an upright position by corralling them and securing them to a cart, framework, or other *fixed object* by use of a restraint.

e. Cylinders must be stored in a cool, well-ventilated area away from ignition and/or heat sources.

f. When not in use, cylinders must always be capped.

g. Cylinder must be labeled "Empty" when empty.

h. Cylinder carts must be used to transport cylinders, and cylinders must be capped and properly secured during transport.

i. Cylinders containing flammable gases must not be stored near oxidizers (minimum 20 ft.

Of separation).

j. Cylinders must not be stored near corrosives.

k. Cylinders must be stored away from doors and exits.

l. Teflon tape nor lubricants should be used on regulator threads

All cylinders (new, used, or empty) must be secured at all times. Chains or belts must be used with properly-tightened clamps or wall mounts to secure cylinders that are not otherwise secured on carts, or in cylinder cages. Restraints must be kept tight at all times, with no appreciable amount of slack. Do not store gas cylinders in the hallway. Protect cylinders from erosion by storing them off the ground in wet or damp locations.

The use of disposable or lecture size cylinders is strongly discouraged. If special circumstances warrant the use of these types of cylinders, the Principal Investigator/Lab Manager is responsible for contacting **EH&S 561-297-3129 or** ehs@fau.edu for disposal of these types of cylinders.
Although cryogenic liquefied gases (e.g. liquid nitrogen) are generally not stored under pressure, laboratory personnel must become familiar with the special hazards associated with the use of these gases. Contact **EH&S 561-297-3129 or** ehs@fau.edu for additional information.

12.5 Moving Chemicals on Campus

Whenever chemicals are moved between labs or storage rooms in the same building, between buildings, or even across campus, the use of secondary containment or overpacking is required as an added safety precaution. Both secondary containment and overpacking help mitigate the adverse effects of a spill or an in-transit container failure by reducing the likelihood of environmental releases and the probability and severity of exposure to harmful chemicals. For those chemicals which are immediately dangerous to life and health (IDLH) when spilled, overpacking is required. When practical, additional secondary containment may also be used in conjunction with overpacking to provide an added level of protection.

Note: For the purposes of this section, secondary containment refers to open top bins, pails, containers, trays, etc. that are moved in an upright position. Overpacking refers to closed top/encapsulating packaging that can hold its contents even if tipped over.

12.5.1 Secondary Containment

The form of secondary containment that is most widely used at the University consists of durable plastic bins. This baseline level of containment is required when moving liquid chemicals and is strongly recommended when moving solid chemicals as well. Solid chemicals may also be moved in cardboard boxes of rigid construction that have completely closed and properly sealed bottoms. For compressed gases contained in lecture bottles, plastic pails serve as an adequate baseline level of containment. Secondary containment is not used for large DOT-approved compressed gas cylinders. Guidance for transporting DOT cylinders can be found in the Compressed Gas Cylinder Section of this CHP.

In all cases, the secondary containment selected must be constructed of material that is compatible with the chemical(s) being moved. The secondary containment must also be strong enough to hold all containers without excessive flexure, and must have enough volume to hold the contents of all containers without overflowing in the event of container failure. As needed, spill pads, cardboard inserts, or bubble wrap can be used to prevent bottles from bumping together while being moved. This practice helps minimize the potential for bottle breakage.

12.5.2 Overpacking

Overpacking is the practice of placing a chemical container within a larger, often padded, sealable container to increase the level of protection in the event of a spill or container failure while being moved. The original DOT-compliant packaging, used to ship the chemical on initial purchase, can always be used as an overpack as long as the outer packaging is in good condition and includes all original inner packaging materials, such as plastic liners, absorbent materials, foam padding, etc. A basic overpack consisting of a larger sealable container, of construction compatible with the chemical being moved, and packed with spill pads, is easily made and effective for most chemicals when the original vendor packaging is unavailable, incomplete, or damaged.

In order to better understand when overpacking is required, the degree of severity of the hazard posed while moving a chemical must be fully understood. The degree of severity of a hazard is a function of a chemical's hazard classification, amount being moved, and relative concentration in mixtures or solutions. Note: Consideration must also be given to the route traveled, weather conditions (if moving chemicals outdoors between buildings), and potential for the presence of other people along your chosen path. Since these three factors are situation and location-specific, they are left to the responsible individual, tasked with moving chemicals, to evaluate on a case-by-case basis.

If you have any questions regarding overpacking, contact EH&S (561-297-3129 or ehs@fau.edu).

12.5.3 Hazard Classification

The safety data sheet (SDS) for a hazardous material is a valuable tool when evaluating the need for overpacking.

Section 2, "Hazards Identification," of GHS-compliant SDSs provides the GHS hazard classifications and category numbers for all pertinent chemical(s) of concern. Under the GHS system, the lower the hazard category number, the higher the hazard. As a general rule of thumb, as the GHS hazard number decreases, the need for additional care while moving chemicals and the necessity for overpacking both increase. Any chemical that is IDLH: explosive/shock sensitive, pyrophoric, water reactive or a strong lachrymator requires overpacking. Those chemicals that have a GHS hazard category of 1 for the following hazard classifications are also considered IDLH and require overpacking:

- Acute toxicity (any route – inhalation, skin absorption, ingestion, or injection)

- Skin corrosion
- Serious Eye Damage

For those chemicals that are GHS hazard category of 2 or 3, overpacking may be appropriate as an added level of protection beyond the baseline practice of using secondary containment. This determination needs to be made on a case-by-case basis and depends on the amount being moved and concentration. GHS hazard category 4 or 5 chemicals do not typically require overpacking; however, they can be overpacked, for added protection, at the discretion of the responsible decision maker, principal investigator, or lab manager.

12.5.4 Amount Being Moved

The amount of chemical being moved can also have an impact on the need for overpacking. Generally, moderate hazard chemicals (with a GHS hazard category of 2 or 3) will not require overpacking if moved in limited quantities, as long as secondary containment is used. If larger amounts of chemicals are to be moved, overpacking should be considered to increase the overall level of protection.

A good example in considering amount as a deciding factor can be found with a chemical such as hexane. Hexane has a hazard category of 2 or 3 for all relevant GHS hazard classifications. When a small bottle of hexane is to be moved, secondary containment is usually adequate. When several 4-liter bottles of hexane are to be moved, overpacking is strongly recommended. In this case, the shipper's original packaging, or a liquid tight container(s) padded with spill pads would both be appropriate.

12.5.5 Concentration

The concentration of a chemical in a solution also plays a significant role in determining the need for overpacking. For those chemicals with a GHS hazard category of 1 that are in solution, concentration is almost directly proportional with the need for overpacking, *i.e.* as concentration increases, so does the necessity of overpacking prior to moving chemicals from place-to-place.

A classic example of how concentration affects the need for overpacking can be found with a chemical such as hydrochloric acid (HCl). Fuming HCl (>37% by volume) has a hazard category of 1 for both serious eye damage and skin corrosion. When the concentration is decreased to 0.1M, the skin corrosion hazard significantly decreases and the hazard category of 1 only remains for serious eye damage. When HCl concentration is further reduced to 0.01M, HCl no longer has a hazard category of 1 for any hazard classification. Fuming HCl should always be overpacked, in the shipper's original packaging or wrapped in spill pads and placed in a larger sealable jar of compatible construction, when moved. The dilute 0.01M HCl solution would require no overpacking and can be moved like any other low- to moderate-hazard liquid in a plastic secondary containment bin.

The chart below is provided as a general guide to better understand when secondary containment and overpacking should be used. Contact **EH&S (561-297-3129 or ehs@fau.edu)** if further assistance is required.

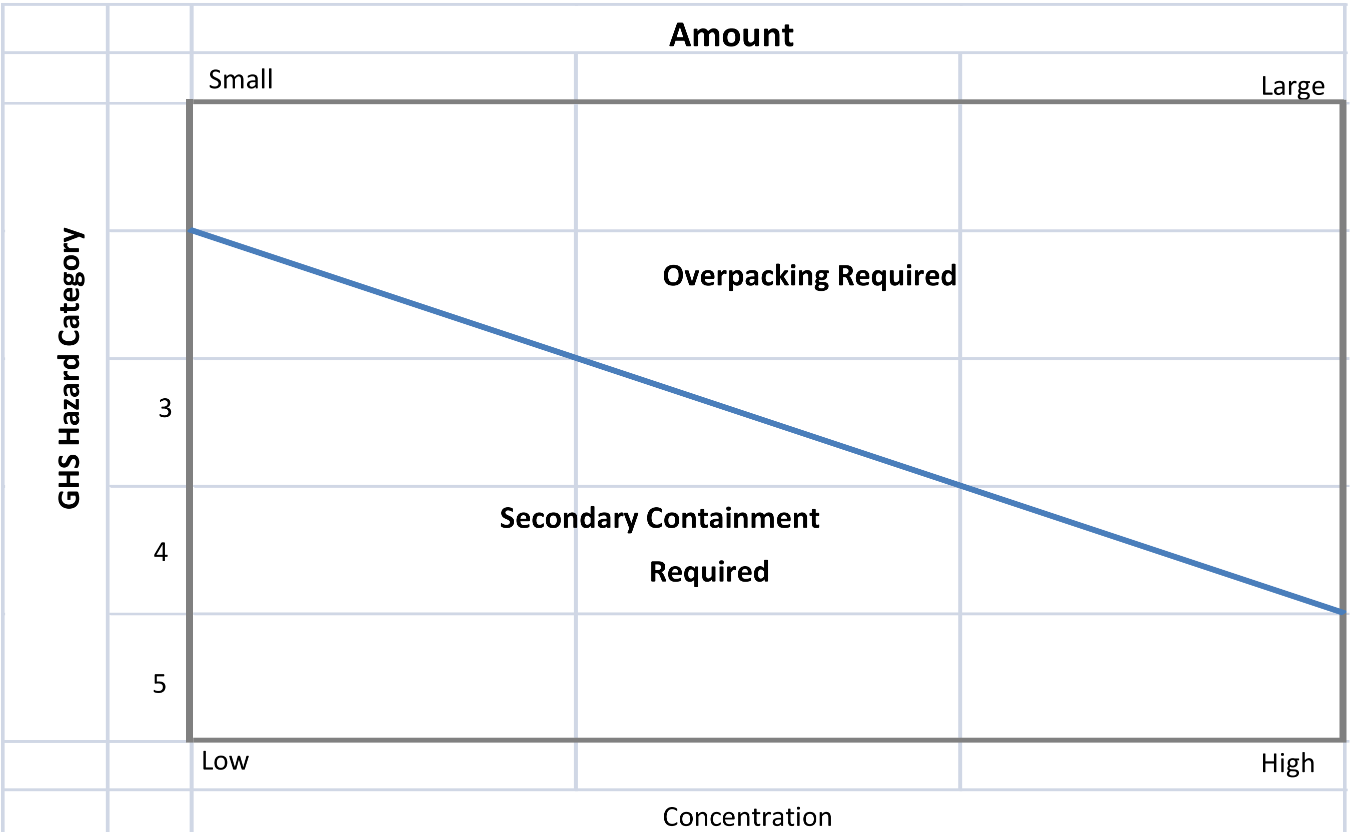

Chart I: Secondary Containment v. Overpacking

12.6 Shipping and Receiving of Hazardous Materials

To assure the safe transport of hazardous materials, the University *must* comply with the United States DOT Hazardous Materials Regulations (49 CFR §171-180) and Department of Homeland Security 6 CFR Part 27 Appendix to Chemical Facility Anti-Terrorism Standards . These regulations cover the shipping and transport of hazardous materials such as infectious substances, toxins, flammables, and explosives. They also contain specific packaging and labeling requirements, and require that all individuals who ship hazardous materials be trained in the proper packaging, labeling, and shipping of such goods.

EH&S is required to notify the Department of Homeland Security if you ship certain listed substances governed by the Chemical Facility Anti-Terrorism Standards (CFATS). FAU does not meet or exceed the minimum Screening Threshold Quantity for any applicable security issue.

Hazardous Materials are defined as, "substances or materials that are capable of posing a significant risk to health, safety, or property when transported." University employees may not be involved in the shipping of hazardous materials, *unless* they have received training, which enables them to properly pack and label hazardous materials and to correctly complete the required shipping papers. Laboratories shipping hazardous chemicals must also provide a (Material) Safety Data Sheet to outside entities who will receive the hazardous chemicals.

Shipping and receiving hazardous materials shall be done in accordance with FAU policies and procedures for dangerous goods. Hazardous materials packages must be inspected at the time of their arrival to ensure that they are not damaged or leaking. Do not accept hazardous materials packages that are not properly labeled in accordance with Department of Transportation (DOT) regulations. Principal Investigators/Lab Managers should date chemical containers, and enter them into the lab inventory upon receipt, and date them again when first opened.

Gifts or donations of chemicals from off-campus sources must be approved by **EH&S** before acceptance.

Contact EH&S for assistance in shipping hazardous materials off campus, or to obtain the required training.

13 Particularly Hazardous Substances

Additional protective measures must be implemented in areas where OSHA "select carcinogens," reproductive toxins, and substances with a high degree of acute toxicity are used. **The Principal Investigator (PI) bears the ultimate responsibility for the safe use of particularly hazardous chemicals in the laboratory.** Researchers must create a *Designated Area* (see definition in the Appendix G: Glossary) in the laboratory that is physically separated and visually labeled with appropriate warnings. Access to the Designated Area must be strictly controlled. Engineering controls (such as fume hoods and biosafety cabinets) must also be located in this Area. Some additional measures to be followed include:

a. Abiding by good industrial/chemical hygiene practices (i.e., no eating drinking or tobacco products, wash hands, use of proper PPE, etc.).

b. Properly handling and storing waste.

c. Using appropriate procedures for decontamination.

The PI using particularly hazardous substances will be responsible for submitting a Standard Operating Procedure (SOP) to **EH&S** for review and approval before the "Designated Area" may become active. The SOP must outline the methods that will be used, the proper handling of chemicals in the "Designated Area" and access restrictions to the area. Researchers should consult the SOP information described in Appendix A of this document to complete their SOPs. Contact **EH&S** with additional questions or concerns.

13.1 Guidelines for Handling Some Specific Hazardous Chemicals

The guidelines that follow, taken from Appendix B of the OSHA Lab Standard (29 CFR§1910.1450), should be adhered to when working with hazardous chemicals of a specific nature. For additional information on the handling, storage or disposal of any of these chemicals, contact **EH&S (561-297-3129 or ehs@fau.edu)**.

13.1.1 Allergens and Embryotoxins

Allergens (diazomethane, isocyanates, and dichromate's) can produce varying degrees of symptoms in the body depending upon individual susceptibility. Lab workers should wear suitable PPE (gloves, lab coats, safety glasses, respirators, etc.) to prevent hand contact with allergens or substances of unknown allergenic activity.

Embryotoxins (organomercurials, lead compounds, formamide) can have degenerative and toxic effects on developing embryos. Women of childbearing age must handle these substances only in a glove box or hood with satisfactory performance. They must also use appropriate protective apparel (gloves, lab coats, etc.) to prevent skin contact.

In addition to these guidelines, the following practices should be instituted when working with allergens and embryotoxins:

a. Review the use of these materials with the research supervisor. Review procedures annually or whenever a procedural change is made.
b. Store these substances in an unbreakable secondary container, properly labeled, and in an area that is secured (capable of being locked) and adequately ventilated.
c. Notify supervisors of all incidents of exposure or spills. Consult a qualified physician when appropriate.

13.1.2 Chemicals of Moderate Chronic or High Acute Toxicity

Certain chemicals have been identified as causing acute and/or chronic health effects. Substances of high acute toxicity cause *immediate* health effects at very low concentrations. Some examples of chemicals with high acute toxicity include the gases hydrogen cyanide, phosgene, and arsine. Substances that have moderate chronic toxicity may cause adverse health effects after repeated exposure over a period of time. These may include carcinogens, teratogens, mutagens, and sensitizers. These supplemental rules should be followed in addition to those for allergens and embryotoxins:

a. *Aim*: To minimize exposure to these toxic substances by any route using all reasonable precautions.

b. *Applicability*: These precautions are appropriate for substances with moderate chronic or high acute toxicity.

c. *Location*: Use and store these substances only in areas of restricted access with special warning signs.

d. *Containment*: Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 100 linear feet per minute) or other containment device for procedures which may result in the generation of aerosols or vapors. Trap released vapors to prevent their discharge.

e. *Personal protection*: Avoid skin contact by use of gloves and long sleeves (and other protective apparel as identified in the (M)SDS or other safety document). Always wash hands and arms immediately after working with these materials.

f. *Records*: Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved.

g. *Prevention of spills and accidents*: Be prepared for accidents and spills. Assure that at least two people are present at all times if a compound in use is highly toxic or of unknown toxicity. Store breakable containers of these substances in chemical resistant trays. Work (including instrumentation areas) and storage areas should be covered with removable, absorbent, plastic backed paper.

h. If a major spill occurs outside the hood, evacuate the area. Contact **EH&S** as soon as possible. Cleanup personnel must wear suitable protective apparel and equipment.

i. *Waste*: Thoroughly decontaminate/dispose of containers, lab ware, and contaminated clothing or shoes in accordance with directions from **EH&S**. Store contaminated waste in closed, properly labeled, impervious containers. Ensure that absorbent material is used to prevent breaking of containers and to absorb any leakage. All materials used must be compatible with the chemicals in the container.

13.1.3 Chemicals of High Chronic Toxicity

These chemicals can produce severe chronic effects in very low doses. Some examples include dimethyl mercury and nickel carbonyl, benzo-a-pyrene, and N-nitrosodiethylamine.

Further supplemental rules to be followed, in addition to all those mentioned above, for work with substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance as identified in a (M)SDS or other safety document, include the following:

a. *Access*: Conduct all transfers and work with these substances in a “Designated Area.” A Designated Area is a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances. Make sure all people with access are aware of the substances being used and of the necessary precautions.

b. *Approvals*: Prepare a plan for the use and disposal of these materials and obtain **EH&S** approval.

c. *Non-contamination/Decontamination*: Protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood. Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the Designated Area.

d. Decontaminate the Designated Area before normal work is resumed there, based on guidance from **EH&S**, SDS, and/or other sources of information.

e. *Exiting*: On leaving a Designated Area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck.

f. *Housekeeping*: Use a wet mop or a vacuum cleaner equipped with a HEPA filter. Avoid dry sweeping powder if the substance was toxic.

g. *Medical surveillance*: If using toxicologically significant quantities (as identified by (M)SDS or other source of safety information) on a regular basis (e.g. 3 times per week), consult a qualified physician concerning regular medical surveillance. If medical surveillance is recommended, consult with **EH&S**.

h. *Records*: Keep accurate records of the amounts of these substances stored and used, the dates of use, names of users, and disposal records.

i. *Signs and labels*: Assure that the Designated Area is conspicuously marked with warning and restricted access signs. Keep all containers appropriately labeled with chemical name and hazard, i.e. "Toxic or Poison."

j. *Spills*: Assure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available.

k. *Storage*: Store containers of these chemicals only in a ventilated, limited access area in appropriately labeled, unbreakable, chemically resistant, secondary containers.

l. *Glove boxes*: For a <u>negative pressure</u> glove box, ventilation rate must be at least 2 volume changes/hour and pressure at least 0.5 inches of water (gauge). For a <u>positive pressure</u> glove box, thoroughly check for leaks before each use. In either case, trap the exit gases or filter them through a HEPA filter and then release them into the hood exhaust. HEPA filters must be evaluated and replaced as necessary by competent laboratory staff. Filters must be disposed of in accordance with hazardous waste regulations. Contact **EH&S** for additional information.

m. *Waste*: Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the Designated Area in a secondary container under the supervision of authorized personnel.

13.1.4 Working with Perchloric Acid

Perchloric acid solutions shall not be evaporated or heated unless the process takes place in a designated perchloric acid fume hood. These special fume hoods are designed in such a way as to allow systematic wash downs with water after using perchloric acid. The evaporation of perchloric acid leads to the formation of highly explosive anhydrous perchloric acid being deposited on the surfaces of ducts. Additionally, evaporated perchloric acid can form equally explosive metallic perchlorate compounds in ductwork.

FAU laboratories lack fume hoods specifically designed for the use of perchloric acid; therefore, use of perchloric acid, when solutions are evaporated or heated, is not permitted, with one exception. In the case of infrequent use of small quantities of perchloric acid, hoods not specifically designed for use with perchloric acid may be permitted to be used if the vapors are trapped and scrubbed prior to release into the hood. Notify EH&S before performing this work.

13.1.4.1 Conducting Procedures with Hydrofluoric Acid

Hydrofluoric acid (HF) is a corrosive material that is dangerous even at low concentrations (50-250ppm) and brief exposure times. Skin contact causes serious skin burns which may not be immediately apparent or painful since HF interferes with nerve function, initially blocking pain. Symptoms may be delayed 8 hours or longer, resulting in deep acid penetration and severe burns. The fluoride ion readily penetrates the skin causing destruction of deep tissue layers and bone. Systemic fluoride poisoning has been associated with sudden death due to cardiac arrest, which can occur with burns to as little as 2.5% of body surface area. Inhalation of HF vapor may cause ulcers of the upper respiratory tract and can also lead to systemic fluoride ion poisoning.

HF should be used in an operational chemical fume hood. In addition to a chemical fume hood, customary PPE including an apron or lab coat, close-toed shoes, goggles, and nitrile gloves, a full face shield and heavy neoprene over-gloves are required. HF is usually stored in polypropylene containers since it attacks glass and other silicon containing compounds. NOTE: HF reacts with silica to produce silicon tetrafluoride, a poisonous, corrosive gas known to cause pneumonitis and pulmonary edema. Older polypropylene containers can become brittle or start to bubble. If such a container is found, contact EH&S immediately. If concentrated HF contacts the skin call 911 immediately and inform medical personnel that a hydrofluoric acid exposure has occurred; also, inform EH&S of the exposure incident.

Labs using hydrofluoric acid must have a supply of either calcium gluconate gel (preferred), or a 10% W/V calcium gluconate solution on hand as an antidote. Topical applications of the gel or solution should be applied frequently and liberally while the victim is awaiting further medical attention. Call **EH&S** for more information.

13.1.5 Nanomaterials

Anyone who uses nanomaterials in research may potentially be exposed to resultant nanoparticles through inhalation, dermal contact, or ingestion, depending upon how nanomaterials are used and handled. Although the potential health effects of such an exposure are not fully understood, scientific studies indicate that at least some of these particles are biologically active, may readily penetrate intact skin, and have produced toxicological reactions in the lungs of exposed animals.

It is important to note that the properties of engineered nanomaterials differ substantially from those of the same material in bulk or macro-scale form. Properties that may be important in understanding the toxic effects of nanomaterials include: particle size and size distribution, agglomeration state, shape, crystal structure, chemical composition, surface area, surface chemistry, surface charge, and porosity.

Research involving the use and/or development of nanomaterials may carry with it the following potential health risks:

- Toxicity of nanoparticles is likely greater than that of the same mass of larger particles.
- Granulomatous pneumonia, fibrosis and other nonmalignant respiratory diseases could result from exposure to nanoparticles.
- Exposure to metal and metal oxide nanoparticles could result in DNA damage.
- Certain nanoparticles may be human carcinogens.

Prior to working with nanomaterials, implement appropriate control measures, and develop SOP(s). Laboratory best practices must also be observed to effectively minimize or eliminate exposure to nanoparticles. Notify EH&S if you plan to use nanomaterials.

14 Chemical Waste Disposal

Standard Operating Procedures (see Appendix A) for each laboratory must include procedures for waste disposal. Each laboratory generating hazardous waste must have at least one lab manager responsible for ensuring that all waste generators within the lab receive annual Hazardous Waste Awareness and Handling Training. Hazardous wastes must be properly containerized, labeled and stored. Contact EH&S for pick up and disposal of hazardous wastes. Hazardous Waste Disposal Procedures for the University are outlined in the **Hazardous Materials Manual**

15 Safety Equipment

In most cases, the following safety items should be readily available in laboratories: fire extinguishers, eyewash/safety showers, spill kits/absorbents, first aid kits, and a telephone with emergency numbers posted on it. Consult EH&S for assistance in determining safety equipment needs for a particular laboratory.

Annual maintenance inspections on fire extinguishers are performed by a licensed fire extinguisher service contractor. Discharged, overcharged, or missing fire extinguishers need to be reported immediately to EH&S.
Eyewash/safety showers should be flushed weekly by laboratory personnel. In order to verify operation and accessibility, laboratory personnel should check all other safety equipment at least

once a week as well. Fume hoods are inspected annually through EH&S (see the section on Fume Hood Performance).

Malfunctioning eyewash/safety showers and fume hoods should be reported immediately to Physical Plant. If the safety equipment is not repaired promptly, please call EH&S. Laboratory operations should be restricted until safety equipment is repaired; no chemical work is to be performed in a malfunctioning fume hood.

Spill Kits and First Aid Kits are to be maintained by individual laboratories or departments. Minimum equipment requirements for spill kits can be found in Appendix E: Hazardous Materials Emergencies and Spills. Emergency contact numbers can also be found in Appendix E.

15.1 Fume Hoods

The fume hood is one of the primary safety engineering controls in the laboratory. **EH&S** will
(1) be responsible for the annual inspection and certification of fume hoods,
(2) monitor the preventive maintenance program for the fume hoods and
(3) coordinate the approval and placement of new (or used) fume hoods in the laboratory.
The purpose of the fume hood is to remove toxic fumes or contaminants from the breathing zone of the user. There are two basic categories of fume hoods: *General Purpose* and *Special Purpose*. Diagrams outlining the general characteristics of fume hoods can be found in Appendix H: Diagrams of Local Exhaust Devices.

15.2 General Purpose Hoods

These hoods are used for laboratory work with materials that do not require special handling procedures. A general-purpose fume hood can be one of four types:
(1) Conventional Hood, the basic hood with a movable sash and baffle. This hood is generally the least expensive and its performance depends mainly on the position of the sash.
(2) By-Pass Hood, designed to allow some exhaust air to "by-pass" the face of the hood even when the sash is closed. It is designed for use with sensitive and fragile apparatus and/or instruments.
(3) Auxiliary Air Hood, designed to introduce outside air into the hood and limit the amount of room air that is exhausted.
(4) Variable Air Volume (VAV) Hood, designed to regulate the hood exhaust and keep the air velocity at a predetermined level.

15.3 Special Purpose Hoods

Certain research activities involve the use of substances that can create dangerous conditions or have clearly defined health hazards. These activities will require specially designed fume hoods to deal with these unique conditions. The most common special purpose fume hoods are perchloric acid and radioisotope fume hoods.

15.3.1 Perchloric Acid Fume Hoods

Procedures with perchloric acid must never be done in a regular fume hood. Special perchloric acid hoods must be used, except in the case of the infrequent use of small quantities of perchloric acid. In this case, a regular fume hood may be used; however, perchloric acid vapor must be trapped and scrubbed prior to release.

Perchloric acid hoods are generally made of non-corrosive materials (stainless steel) and are equipped with a water wash down mechanism in the ductwork. Perchloric acid fume hoods must be clearly labeled and used only for perchloric acid or other mineral acids, such as nitric, hydrochloric, and hydrofluoric. **No organic solvents should be stored or used in these hoods**. When perchloric acid is heated above ambient temperature, vapor is formed which can condense in the ductwork and form explosive perchlorates. After each use, the fume hood operator shall wash down the hood and ductwork with water.

15.3.2 Radioisotope Fume Hoods

Any research activity involving volatile radionuclides must be done in a fume hood appropriate for such activities and must meet the requirements set forth by the FAU Radiation Safety Officer (RSO). These requirements include, but are not limited to, the following:

a. Certification before procedures begin and at routine intervals thereafter, not to exceed one year.

b. Establishment of a minimum flow rate of 100 linear feet per minute (lfpm) across the sash opening of the fume hood with a minimum face area (the region between the sash level and the bottom airfoil-see diagram in *Appendix H*) of four square feet.

c. Operation twenty-four hours per day, 365 days per year for those hoods used with tritium or radioiodine.

d. Thyroid bioassays are required for individuals working with volatile I125 in quantities greater than 1mCi.

Maintenance of a Use Log for each radioisotope fume hood is required to assure that the established release limits are not exceeded.

15.4 General Safety Practices for Fume Hoods

a. Fume hoods are *not* designed for storage. Items (equipment, chemicals, etc.) within the fume hood should be minimized as they can reduce fume hood performance. Remove all items not required for procedures in progress.

b. Fume hoods should be equipped with "Magnehelic" gauges or flow meters with low flow alarms to ensure that the hoods are functioning properly. In the absence of gauges or meters, a convenient test method is to use a tissue paper streamer attached to the bottom of the sash.

c. All work should be at least six inches behind the plane of the face (sash opening) of a fume hood.

d. Any items within a hood must not obstruct the baffle openings or impede airflow at the face of the fume hood.

e. Fume hoods should be operated with sashes lowered whenever possible.

f. Fume hood baffles are set to exhaust equally from the top, middle, and bottom zones of the hood. Baffle adjustments should only be made after consultation with EH&S.

g. Fume hoods may fail for a variety of reasons. Lab personnel should have a contingency plan for hood failure to prevent development of hazardous conditions, and to avoid interruptions in laboratory use.

15.5 Biosafety Cabinets and Laminar Flow Hoods

15.5.1 Biosafety Cabinets

The Biological Safety Cabinet (BSC) is another primary engineering control in the laboratory. It is commonly used as a containment and protection device in laboratories working with biological agents. The major functional element of a BSC is its ability to create a near-sterile environment through the use of High Efficiency Particulate Air (HEPA) filters. The size, location, and placement of these filters will determine the class and function of a biological safety cabinet.

There are three different classes of BSCs which are not directly related to the Biological Safety Levels (BSLs) required for the microbiological agent being used. Generally, Class I and Class II cabinets can be used for work at BSLs 1 to 3. Class III cabinets are usually reserved for work at BSL4, although a Class II cabinet can be used at this level if the appropriate personal protective equipment is used. For more information on BSCs refer to the Biological Safety Manual.

15.6 Laminar Flow Hoods

The term "laminar flow" describes the air purifying action of these hoods because they provide a directed, non-mixing air stream through a HEPA filter. They can also be called "clean benches" because they provide a near sterile work area. **However, these hoods do not provide protection to the user from contamination and, in fact, can expose the worker to aerosols of allergenic or infectious materials**. Researchers therefore must not confuse these hoods with biological safety cabinets. These hoods must not be used for microbiological work with potential pathogens.

Please consult Appendix H for diagrams of the basic components of laminar flow hoods and biosafety cabinets.

15.7 Materials, Designs and Construction

All materials design and construction of BSCs and laminar flow hoods shall abide by the **National Sanitation Foundation (NSF) Standard 49**.

15.8 Performance, Inspection and Certification

Every new BSC must be performance tested by the manufacturer according to the requirements listed in the **NSF Standard**. BSCs convertible from one type to another should be performance tested in each mode. Field certification by authorized individuals or companies should include, but not be limited to, the following testing procedures (described in **NSF Standard 49**):

a. Soap Bubble/Halogen Leak
b. HEPA Filter Leak
c. Velocity Profile
d. Vibration sensitivity
e. Noise level
f. Airflow Smoke Patterns

In addition, each BSC must have a certificate of inspection that should include, but not be limited to, the date of certification, the name of the person who performed the inspection, and the date for the next inspection. **Certification of biosafety cabinets must be done annually, whenever relocated, or if a problem is suspected.**

Since laminar flow hoods are not used to provide protection to the user, these devices should be certified annually to prevent product contamination. A list of licensed certification companies is available on the **EH&S** web site under the "Biological Safety" link.

15.9 Local Exhaust Enclosures and Snorkels

Local exhaust enclosures and snorkels are only appropriate for use with low-hazard materials. These devices are not an appropriate substitute for fume hoods or biosafety cabinets, which have significantly higher capture efficiencies. **Use of local exhaust enclosures or snorkels with moderate- to high-hazard materials can result in serious injury or death**.
Local exhaust enclosures and snorkels may be used to help an already-effective general ventilation system achieve the following:

a. Control of nuisance-level dust, fume, and vapor in labs and other workspaces
b. Enhanced removal of low-hazard airborne contaminants
c. Increased worker comfort

Contact EH&S if you require assistance in determining the suitability of local exhaust enclosures or snorkels for your specific application.

16 Employee Information and Training

An essential component of the Chemical Hygiene Plan (CHP) is providing information and training to all laboratory workers. This information and training will ensure that laboratory workers are aware of the hazards posed by chemicals in their work areas and how to protect themselves from these hazards.

All employees will be informed and trained about the hazards in the work area at the time of initial assignment and prior to work involving new exposure situations. Refresher training will occur annually.

16.1 Employee Information

Laboratory workers will be informed of, and provided access to the following:

a. Contents and appendices of the "OSHA Lab Standard" (29 CFR§1910.1450).

b. Contents and appendices of the CHP.

c. Mandatory and recommended exposure limits for hazardous chemicals.

d. The signs and symptoms associated with exposures to hazardous chemicals.

e. The location and availability of safety reference materials, including (M)SDSs, for hazardous chemicals.

16.2 Employee Training

At a minimum, employee training will include:

a. Methods used to detect the presence or release of hazardous chemicals.

b. Physical and health hazards of chemicals in the work area.

c. Protective measures used to reduce hazards or exposures.

d. Applicable details of the CHP.

16.3 Information and Training Responsibilities

To satisfy the information and training requirements outlined above; laboratory workers must receive Laboratory Safety and Hazardous Waste Awareness and Handling training. EH&S will provide these trainings to departments upon request and as otherwise scheduled or using a selfenroll training platform (see www.fau.edu/ehs/training). EH&S will document and maintain records of such training and assist departments in tracking their refresher training needs.

Departments must identify laboratory workers who require training and ensure workers attend training sessions, including refresher training. Principal investigators and lab managers must also provide on-the-job, lab specific safety training to laboratory workers.

17 Laboratory Signage

The goal of Laboratory signage is to protect human health and safety, protect research, and identify what types of PPE and information are needed before entering the laboratory and to alert unsuspecting visitors to the potential hazards within the space.

At a minimum, Laboratory entrance doors will include the following signage:

a. Name and contact information for Laboratory Director, Manager, and/or Supervisors.
b. Emergency contact for spills or accidental releases.
c. Minimum level of PPE required for entry into the space, i.e. lab coat, safety glasses, gloves, etc.
d. Indicate "Restricted Area, Authorized Personnel Only"
e. Individual signs for the following agents if they are present within the laboratory;
f. Lasers (include highest classification used)
g. Biologicals (include highest BSL classification used)
h. Radiation
i. Chemicals (include type of hazards, i.e. flammable, corrosive, toxic)

Labs or storage areas which can only be accessed via another lab, the door to which is already posted, need not be individually posted but the hazards they contain must also be represented on the sign posted on the exterior access door.

Privacy shielding is recommended on any windows to laboratory space containing animals for the comfort and wellbeing of the animals housed inside.

18 Laboratory Inspection

Environmental Health and Safety will conduct a variety of laboratory inspections of University facilities, and accompany inspectors from external regulatory agencies during inspections of University facilities. Inspections are conducted using the FAU Environmental Health and Safety Inspection Policy #09. Prior to the annual EH&S Laboratory Inspection, the PI/lab manager or responsible personnel should submit an up-to-date chemical inventory to EH&S (ehs@fau.edu).

Appendix A: Standard Operating Procedures

Each laboratory must write specific standard operating procedures (SOPs) for work involving the use of hazardous chemicals. See the definition of "Hazardous Chemical" in the Definitions section of this document. In most cases, more than one SOP will be required. All hazardous chemicals used in the laboratory must be covered by an SOP, and these SOPs must be maintained with the Chemical Hygiene Plan in the laboratory.

There are three methods that can be used to write SOPs:

1. by process (distillation, synthesis, chromatography, etc.).
2. by individual hazardous chemical (arsenic, benzene, hydrochloric acid, etc.).
3. by hazardous chemical class (flammables, corrosives, oxidizers, etc.).

These methods may be used alone or in combination. Two forms are provided (an example and a blank) in this appendix to assist in the preparation of SOPs. The blank form consists of eleven sections and should contain the information listed below. Sample SOPs for some common laboratory chemicals can be found on the EH&S web site under the "Chemical Safety Program" link. Contact **EH&S** for assistance in developing appropriate SOPs.

SOP Format

Sect. 1. Process, Hazardous Chemical, or Hazard Class - circle one.

Sect. 2. Describe Process, Hazardous Chemical, or Hazard Class.

Process - Describe the process, which involves hazardous chemicals. List all chemicals used in the process.

Hazardous Chemical - Name the hazardous chemical for which the SOP is being developed. Include International Union of Pure and Applied Chemistry (IUPAC), common name, and any abbreviation(s) used for the chemical.

Hazard Class - Describe the hazard associated with a particular group of similar chemicals and list the chemicals used in the laboratory.

Sect 3. Potential Hazards - Describe the potential hazards for each process, hazardous chemical or hazard class. Include physical and health hazards. Consult SDS and other chemical literature.

Sect. 4. Personal Protective Equipment (PPE) - Identify the required level of PPE and hygiene practices needed for each process, hazardous chemical or hazard class. PPE includes gloves, aprons, lab coats, safety glasses, goggles, face-shields, and respirators. **Note: Before using respirators, all employees must comply with the University's Respiratory Protection Program. Call EH&S for more information**.

Sect. 5. Engineering Controls - Describe engineering controls that will be used to minimize or eliminate employee exposure to hazardous chemicals during the process. This includes ventilation devices such as fume hoods, gloveboxes, blast shields, etc.

Sect. 6. Special Handling & Storage Requirements - List storage requirements for the hazardous chemicals involved with the SOP, including specific storage areas, temperatures, and policies regarding access to chemicals. Special procedures such as dating peroxide formers and testing them before distillation are appropriate here.

Sect. 7. Spill and Accident Procedures - Indicate how spills or accidental releases will be handled and by whom. List the location of appropriate emergency equipment (spill kits, showers, eyewashes, and fire equipment). Any special requirements for personnel exposure should also be identified in this section. Identify the location of emergency response phone numbers.

Sect. 8. Decontamination Procedures - Specify decontamination procedures to be used for equipment, glassware and clothing: include equipment such as glove boxes, hoods, lab benches, and designated areas within the laboratory.

Sect. 9. Waste Disposal Procedures - Indicate how wastes will be disposed. Include the name of the person responsible for managing laboratory waste. See also Hazardous Materials Manual.

Sect. 10. Safety Data Sheet Location - Indicate the location of SDSs for each hazardous chemical used. Also, indicate the location of other pertinent safety information, i.e. equipment manuals, chemical references, etc.

Sect. 11. Principal Investigator/Lab Manager Approval – Sign and date to indicate the SOP has been approved.

SAMPLE: Standard Operating Procedure

Location: _____________ Principal Investigator: __________________________ Date: ______________

Section. 1. Process, Hazardous Chemical, or Hazard Class - circle one.

Section 2. Describe Hazard Class- **Concentrated inorganic acid solutions. Examples are hydrochloric and sulfuric acids**

Section 3. Potential Hazards- Corrosive material, Inhalation of vapor is harmful, could damage lungs. Ingestion may be fatal. Liquid can cause severe damage to skin and eyes. Strong inorganic acid mists containing Sulfuric acid can cause cancer.

Section 4. Personal Protective Equipment- When working with small amounts use chemical safety glasses and butyl or neoprene gloves. Must have proper exhaust ventilation in room or use a fume hood. When pouring large amounts, use safety goggles a face shield, long gloves and a chemical resistant apron.

Section 5. Engineering Controls- When possible, dispense chemical in a fume hood. The room where the chemical is being used should be equipped with proper exhaust ventilation to keep the airborne concentration below the allowable exposure limit. Eye wash station and a safety shower must be accessible within a 10 second travel time and not require passage through more than one door.

Section 6. Special Handling and Storage Requirements- Store in a cool, dry, ventilated area with other compatible substances. Keep away from strong bases, oxidizers, cyanides, organic materials and metals such as zinc and mercury. Do not store in metal containers. When diluting, always add the acid into water slowly, never the other way around. Containers of this product are hazardous when empty until neutralized with a mild Sodium Bicarbonate solution.

Section 7. Spill and Accident Procedures-

Inhalation: Remove to fresh air. If not breathing, give artificial respiration. Get medical attention immediately.

Ingestion: DO NOT INDUCE VOMITING. Give large quantities of water or milk. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Contact: Immediately flush skin with copious amounts of water for at least 15 minutes while removing any contaminated clothing. Get medical attention immediately. Never use neutralizers on skin.

Eye Contact: Immediately flush eyes with copious amounts of water for at least 15 minutes. Get medical attention immediately.

Small Spills (One Liter or less): Ventilate the area and use proper personal protective equipment. Neutralize with alkaline material such as Soda Ash or Sodium Bicarbonate. Absorb the material with an inert absorbent such as vermiculite or sand and place in a suitable container for disposal and notify EH&S for pickup.

Large Spills (More than a Liter): Notify those affected by the spill and turn off all ignition sources. Evacuate the area and call Environmental Health and Safety at 297-3129 or campus police at 297-3500. Restrict people from entering the affected area until cleanup is completed.

Section 8. Decontamination Procedures- To decontaminate, wipe areas with a mild solution of Sodium Bicarbonate. Place all material in a container labeled with the words "Hazardous Waste" and the contents, and notify EH&S for pickup.

Section 9. Waste Disposal Procedures- Place waste in an appropriate and compatible container. Container must be closed and labeled with the words "Hazardous Waste" and with the main constituents. Place waste in waste collection area and submit Waste Pick-up form to EH&S at ehs@fau.edu or call EH&S at 297-3129.

Section 10. Safety Data Sheets Locations- (Material) Safety Data Sheets are kept in a binder labeled (M)SDS in room___, or may be found on the web at either www.siri.org or www.fau.edu/ehs.

Section 11. Principal Investigator/ Lab Manager Approval: Signature: ____________________________________

Date: ____

Standard Operating Procedure

Location: ______________ Principal Investigator: ____________________________ Date: _______________

Section 1. Process, Hazardous Chemical, or Hazard Class - circle one.

Section 2. Describe Process, Hazardous Chemical, or Hazard Class.

Section 3. Potential Hazards

Section 4. Personal Protective Equipment

Section 5. Engineering Controls

Section 6. Special Handling and Storage Requirements

Section 7. Spill and Accident Procedures

Section 8. Decontamination Procedures

Section 9. Waste Disposal Procedures

Section 10. Material Safety Data Sheet Locations

Section 11. Principal Investigator/Lab Manager Approval:

Signature: ____
Date: ____

Appendix B – Storage Limits for Highly Hazardous Chemicals

Table VI Storage Limits for Common Peroxidizable Compounds

See FAU PEC (Potentially Explosive Chemicals) Guidelines Document for more information.

Class A - HIGHLY HAZARDOUS: Discard on or before **3 months**.

Peroxide formation hazard during storage.

isopropyl ether	divinyl acetylene
vinylidene chloride	potassium metal
sodium amide	potassium amide

Class B - HAZARDOUS: Discard or test after 6 months.

Peroxide formation hazard during storage and on concentration (i.e. distillation) of compound

diethyl ether	dicyclopentadiene
tetrahydrofuran	diacetylene
dioxane	methyl acetylene
acetal	cumene
methyl isobutyl ketone	tetrahydronaphthalene
ethylene glycol dimethyl ether	cyclohexene
vinyl ethers	methylcyclopentane

CLASS C – POTENTIALLY HAZARDOUS: Discard or test after one year.

Peroxide formation causes initiation of hazardous polymerization.

methyl methacrylate	chorotrifluoroethylene
styrene	vinyl acetylene
acrylic acid	vinyl acetate
acrylonitrile	vinyl chloride
butadiene	vinyl pyridine
tetrafluoroethylene	chloroprene

More Safety Points:

1. Do not purchase these compounds in quantities greater than can be used in the specified storage period.
2. Ethers should be stored in the dark and under nitrogen if possible.
3. Always check for the presence of peroxides before distilling any peroxide former.
4. Consult safety references before working with peroxidizable compounds.

Table VII Short List of Incompatible Materials

ALKALI METALS, such as calcium, potassium, and sodium with: water, carbon dioxide, carbon tetrachloride, and other chlorinated hydrocarbons.	**ACETIC ACID** with: chromic acid, nitric acid, hydroxyl containing compounds, ethylene glycol, perchloric acid, peroxides, and permanganates.
ACETONE with: concentrated sulfuric acid and nitric acid mixtures.	**ACETYLENE** with: copper (tubing), fluorine, bromine, chlorine, iodine, silver, mercury, or their compounds.
AMMONIA, ANHYDROUS with: mercury, halogens, calcium hypochlorite, or hydrogen fluoride.	**AMMONIUM NITRATE** with: acids, metal powders, flammable liquids, chlorates, nitrates, sulfur, and finely divided organics or other combustibles.
ANILINE with: nitric acid, hydrogen peroxide, or other strong oxidizing substances.	**BROMINE** with: ammonia, acetylene, butadiene, butane, hydrogen, sodium carbide, turpentine, or finely divided metals.
CHLORATES with: ammonium salts, acids, metal powders, sulfur, carbon, finely divided organics or other combustibles.	**CHROMIC ACID** with: acetic acid, naphthalene, camphor, alcohol, glycerin, turpentine, and other flammable liquids.
CHLORINE with: ammonia, acetylene, butadiene, benzene and other petroleum fractions, hydrogen, sodium carbides, turpentine, and finely divided metals.	**CYANIDES** with: acids.
HYDROGEN PEROXIDE with: copper, chromium, iron, most metals or their respective salts, flammable liquids and other combustible materials, aniline, and nitromethane.	**HYDROGEN SULFIDE** with: nitric acid, oxidizing gases.
HYDROCARBONS, generally, with: fluorine, chlorine, bromine, chromic acid, or sodium peroxide.	**IODINE** with: acetylene or ammonia.
MERCURY with: acetylene, fluminic acid, or hydrogen.	**NITRIC ACID** with: acetic, chromic, or hydrocyanic acids, aniline, carbon, hydrogen sulfide, flammable liquids or gases, or other substances which are readily nitrated.
OXYGEN with: oils greases, hydrogen, flammable liquids, solids, or gases.	**OXALIC ACID** with: silver or mercury
PERCHLORIC ACID with: acetic anhydride, bismuth and its alloys, alcohol, paper, wood, and other organic materials.	**PHOSPHOROUS PENTOXIDE** with: water.
POTASSIUM PERMANGANATE with: glycerin, ethylene glycol, benzaldehyde, or sulfuric acid.	**SODIUM PEROXIDE** with: any oxidizable substances, for instance: methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, furfural, etc.
SULFURIC ACID with: chlorates, perchlorates, permanganates, and water	

NOTE: This list is not a complete list of incompatible materials. It contains some of the more common incompatible materials. Always research the materials you work with in order to be safe.

A. Shock Sensitive Compounds

Acetylenic compounds - especially polyacetylenes, haloacetylenes and heavy metal salts of acetylenes (copper, silver, and mercury salts are particularly sensitive).

Acyl nitrates

Alkyl nitrates - particularly poly nitrates (i.e. nitrocellulose and nitroglycerine).

Alkyl and acyl nitrites

Alkyl perchlorates

Amminemetal oxosalts – metal compounds with coordinated ammonia, hydrazine or similar nitrogenous donors and ionic perchlorate, nitrate, permanganate or other oxidizing groups.

Azides – including metal, nonmetal and other organic azides.

Chlorite salts or metals (i.e. $AgCLO_2$ and $Hg (ClO_2)_2$

Diazo compounds (i.e. CH_2N_2)

Diazonium salts (when dry)

Fulminates – silver fulminate (AgCNO) can form in the reaction mixture from the Tollen' test for aldehydes if it is allowed to stand for some time; this can be prevented by adding dilute nitric acid to the test mixture as soon as the test has been completed.

Hydrogen peroxide – becomes increasingly treacherous as the concentration rises above 30%, forming explosive mixtures with organic materials and decomposing violently in the presence of traces of transition metals.

N-Halogen compounds (i.e. difluoroamino compounds and halogen azides).

N-Nitro compounds (i.e. N-nitromethylamine, nitrourea, nitroguanidine and nitric amide).

Oxo salts of nitrogenous bases – perchlorates, dichromates, nitrates, iodates, chlorites, chlorates and permanganates of ammonia, amines, hydroxylamine, guanidine, etc.

Perchlorate salts – most metal, nonmetal and amine perchlorates can be detonated and may undergo violent reaction in contact with combustible materials.

Peroxides and hydroperoxides, organic

Peroxides (solid) - crystallized form or are left from evaporation of peroxidizable solvents.

Peroxides - transition-metal salts

Picrates - especially salts of transition and heavy metals (i.e. Ni, Pb, Hg, Cu and Zn); picric acid is explosive but less sensitive to shock or friction than its metal salts and is relatively safe a s long as wetted and not dried out.

Polynitroalkyl compounds (i.e. tetranitromethane and dinitroacetonitrile)

Polynitroaromatic compounds - especially polynitro hydrocarbons, phenols and amines

Appendix C: Glove Selection Chart

The following guide was developed from information in several sources.* Many factors affect the breakthrough times of glove materials including, but not limited to, the thickness of glove material, concentration of the chemical, amount of chemical the glove comes in contact with, length of time the glove is exposed to the chemical, the temperature and abrasion or puncture.

General Safety Procedures

This information is provided as a guide to proper glove material selection. Glove performance varies between manufacturers, so before working with any highly toxic chemical always consult the manufacturer to make sure that the correct gloves are used for the application. Generally, **Nitrile** is recommended as a good all-purpose glove for non-toxic chemicals. Silver Shield or Laminate Film are the best gloves for more toxic or unknown hazards, **BUT** always check with the manufacturer before using with any toxic or unknown substance. When using gloves follow these safety procedures:

- Make sure the glove material is resistant and compatible with the substances in use.
- Inspect gloves for holes and tears before each use.
- Wash gloves appropriately before removing them.
- In order to prevent the unintentional spread of hazardous substances, remove gloves before handling objects such as doorknobs, telephones, pens etc. and before leaving the laboratory.
- Replace gloves periodically, depending on their permeation and degradation characteristics.

Selection Key:

4 = Excellent, breakthrough times generally greater than 8 hours.

3 = Good, breakthrough times generally greater than 4 hours.

2 = Fair, breakthrough times generally greater than 1 hour.

1 = Not Recommended, breakthrough times generally less than 1 hour.

? = Not Tested or No Information, check other references.

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* Sources:
ILC Dover Chemical Compatibility Chart.
Glove Resistance Ratings, James North & Sons, Inc.
Quick Selection Guide to Chemical Protective Clothing,
2nd Edition, Forsberg & Mansdorf.

TABLE VIII Glove Selection Guide

Chemical	Natural Rubber	Neoprene	Butyl	PVC	Nitrile	Viton ®
Alcohols						
Allyl alcohol	1	1	4	1	4	3
Butyl alcohol	1	3	4	2	3	4
Ethyl alcohol	1	2	4	1	3	4
Isopropyl alcohol	1	3	4	2	4	4
Methyl alcohol	1	1	4	1	1	4
Aldehydes						
Acetaldehyde	1	1	4	1	1	1
Acrolein	1	1	4	1	1	1
Benzaldehyde	1	1	4	1	1	3
Butyraldehyde	1	1	4	1	1	1
Formaldehyde	1	2	4	2	4	4
Glutaraldehyde	?	4	4	2	?	4
Aliphatic Hydrocarbons						
Diesel Fuel	1	2	1	2	3	4
Hexanes	1	1	1	1	4	4
Kerosene	1	3	1	3	4	4
Naphtha	1	2	1	3	4	4

Chemical	Natural Rubber	Neoprene	Butyl	PVC	Nitrile	Viton ®
Pentane	1	1	1	1	3	4
Petroleum Ether	1	1	1	2	3	4
Turpentine	1	1	1	1	2	4
Alkalis						
Ammonium Hydroxide up to 70%	1	3	4	2	3	?
Potassium Hydroxide up to 70 %	4	4	4	4	4	4
Sodium Hydroxide 70 + %	4	4	4	4	3	3
Amines						
Aniline	1	1	1	1	2	1
Ethanolamine	2	4	4	3	4	4
Ethylamine	1	2	4	1	1	1
Methylamine	1	3	4	2	4	4
Triethanolamine	1	1	4	1	4	4
Aromatic Hydrocarbons						
Benzene	1	1	1	1	1	3
Gasoline	1	1	1	1	4	4
Naphthalene	1	1	1	1	4	4
Toluene	1	1	1	1	1	4
Xylene	1	1	1	1	1	4

Chemical	Natural Rubber	Neoprene	Butyl	PVC	Nitrile	Viton ®
Elements						
Bromine	1	2	1	?	1	4
Chlorine aqueous	?	1	2	?	1	4
Iodine	?	1	3	?	3	4
Mercury	?	4	4	?	4	4
Esters						
Ethyl acetate	1	1	3	1	1	1
Butyl acetate	1	1	2	1	1	1
Methyl acetate	1	1	4	1	1	1
Isobutyl acrylate	1	1	4	1	1	1
Ethers/Glycols						
Diethyl ether	1	2	1	1	2	1
Ethylene glycol	1	2	4	1	2	4
Isopropyl ether	1	2	1	1	3	1
Propylene glycol	?	3	3	2	2	?
Tetrahydrofuran	1	1	2	1	1	1

Chemical	Natural Rubber	Neoprene	Butyl	PVC	Nitrile	Viton ®
			Halogenated Hydrocarbons			
Carbon Tetrachloride	1	1	1	1	1	4
Chloroform	1	1	1	1	1	4
Methylene Chloride	1	1	1	1	2	3
Polychlorinated Biphenyls(PCB's)	1	4	4	?	2	4
Perchloroethylene	1	1	1	1	2	4
Trichloroethylene	1	1	1	1	1	4
			Inorganic Acids			
Chromic acid up to 70%	1	1	4	3	3	4
Hydrochloric acid up to 37%	3	3	4	3	3	3
Hydrofluoric acid up to 70%	2	2	3	1	1	?
Nitric acid 70+ %	?	1	2	?	1	4
Perchloric acid up to 70%	4	4	3	4	4	4
Phosphoric acid 70+ %	4	4	4	4	4	4
Sulfuric acid 70+ %	1	2	4	2	1	2
			Ketones			
Acetone	1	1	4	1	1	1
Diisobutyl ketone	1	1	2	1	1	2
Methyl ethyl ketone	1	1	4	1	1	1

Chemical	Natural Rubber	Neoprene	Butyl	PVC	Nitrile	Viton ®
Miscellaneous						
Acetic anhydride	1	2	4	1	1	1
Acetonitrile	1	1	4	1	1	1
Acrylamide	1	1	3	1	2	3
Carbon disulfide	1	1	1	1	1	4
Cresols	1	3	4	?	2	4
Cutting fluid	?	2	?	2	3	?
Dimethyl sulfoxide	1	4	4	1	1	1
Hydraulic oil	?	?	1	2	3	?
Hydrazine	2	4	4	4	4	1
Hydrogen Peroxide	4	2	4	3	4	4
Lubricating oil	3	3	?	?	4	3
Malathion	?	3	1	?	3	?
Nitrobenzene	1	1	4	1	1	4
Phenol	1	3	2	1	1	4
Photo solutions	3	4	?	3	4	?
Picric acid	1	2	3	1	2	4

Chemical	Natural Rubber	Neoprene	Butyl	PVC	Nitrile	Viton ®
Pyridine	1	1	4	1	1	1

Organic Acids

Chemical	Natural Rubber	Neoprene	Butyl	PVC	Nitrile	Viton ®
Acetic acid	2	3	4	2	1	4
Formic acid	2	3	4	3	2	2
Lactic Acid	4	4	4	3	4	4
Maleic acid	3	3	2	3	3	4
Oxalic Acid	4	4	4	4	4	4

Salt Solutions

Chemical	Natural Rubber	Neoprene	Butyl	PVC	Nitrile	Viton ®
Ammonium nitrate	4	4	4	4	4	4
Calcium hypochlorite	1	3	4	4	3	4
Ferric chloride	4	4	4	4	4	4
Mercuric chloride	3	3	4	3	3	4
Potassium cyanide	4	4	4	4	4	4
Potassium dichromate	4	4	4	4	4	4
Potassium permanganate	4	4	?	4	4	?
Sodium cyanide	4	4	4	4	4	4
Sodium thiosulfate	4	4	4	4	4	4

Appendix D: References & Acknowledgements

The following sources were consulted during the development of the FAU Chemical Hygiene Plan:

- Hazard Communication Standard (OSHA) 29 CFR 1910.1200, Chapter 442,F.S., Rule 38I-20.003 F.A.C.
- Hazardous Waste Management (EPA) 40 CFR§260-299, Rule 62-730, F.A.C.
- Occupational Exposure to Hazardous Chemicals in Laboratories (OSHA) 29 CFR§1910.1450, Rule 38I-20.003 F.A.C.
- "Safety in Academic Chemistry Laboratories"; American Chemical Society, Washington D.C., 1994.
- Prudent Practices in Laboratories, Handling and Disposal of Chemicals; National Academy of Sciences, Washington D.C., 1995.
- "Flammable and Combustible Liquids Code"; NFPA Standard 30, National Fire Protection Association, Quincy, MA, 1993.
- Boca Raton, Florida, Municipal Code Ch. 17, Art. IV § 17-103 (2010).
- “Managing Spent Fluorescent and High Intensity Discharge (HID) Lamps, A Fact Sheet for Florida Businesses and Government Facilities”; Florida Department of Environmental Protection, Tallahassee FL, 2008.
- Universal Pharmaceutical Waste, Rule 62-730.186, F.A.C.
- Used Oil Management, Rule 62-710, F.A.C.
- "Lists of Carcinogens and Reproductive Toxins," Seventh Annual Report on Carcinogens, Summary 1994, U.S. Dept. of Public Health Services.
- Johns Hopkins University Safety Manual.
- The Florida State University Chemical Hygiene Plan
- The Harvard University, Longwood Area, Chemical Hygiene Plan.
- The University of Southern California Laboratory Safety Program.
- The University of West Florida Chemical Hygiene Plan.
- The University of Miami Laboratory Safety Manual.
- Boca Raton, Florida, Municipal Code Ch. 17, Art. IV § 17-103 (2010).

- “Managing Spent Fluorescent and High Intensity Discharge (HID) Lamps, A Fact Sheet for Florida Businesses and Government Facilities”; Florida Department of Environmental Protection, Tallahassee FL, 2008.
- Universal Pharmaceutical Waste, Rule 62-730.186, F.A.C.
- Used Oil Management, Rule 62-710, F.A.C.

Appendix E: Hazardous Material Emergencies and Spills

The following guidelines and procedures are to be used in case of chemical emergencies or spills. For more detailed information on any of these subjects, contact **EH&S.**

Chemical Exposures

Inhalation: Remove to fresh air. If not breathing, give artificial respiration. Seek medical attention immediately.

Eye Contact: If a chemical has been splashed into the eyes, immediately wash the eye and inner surface of the eyelids with copious amounts of water for 15 minutes, lifting upper and lower eyelids occasionally. Check for and remove any contact lenses at once. Seek medical attention immediately.

Ingestion: Consult SDS, and/or call the Poison Control Information Center at 1-800-222-1222. Follow directions and seek medical attention immediately.

Minor Skin Contact: Promptly flush the affected area with water and remove any contaminated clothing. If symptoms persist after washing, seek medical attention.

Major Skin Contact: If chemicals have been spilled over a large area of the body, quickly remove all contaminated clothing while using the safety shower. Repeat if pain returns. Wash off chemicals by using a mild detergent or soap and water. Do not neutralize chemicals or apply salves or bandages. Leave affected area clean and open to the air. Seek medical attention immediately.

Remember that for some chemicals, such as hydrofluoric acid, effects resulting from exposure may not become apparent until hours or days later. Consult the SDS for any chemical to which someone has been exposed, even if no immediate injury is apparent.

If clothing is on fire, help the individual to the floor and roll that person around to smother the flames. If a safety shower is immediately available, douse the person with water; running to a remote shower will only fan the flame.

Report instances of chemical exposure to EH&S after medical attention has been received.

Accident Reporting & Workers Compensation Procedures

All accidents, injuries, or incidents must be reported to the supervisor or other person in charge. Accidents and injuries resulting in the need for first aid, medical attention, or lost worktime must be documented. Persons responsible for the affected individual(s) must complete the appropriate report. (See University Accident Reporting Procedures.)

Emergencies

All laboratory personnel must know what to do in case of an emergency. Laboratory work must not be undertaken without knowledge of the following points:

- How to report a fire, injury, chemical spill, or other emergency.
- The location of emergency equipment such as safety showers and eyewash fountains.
- The location of fire extinguishers and spill control equipment.
- The locations of all available exits for evacuation from the laboratory.
- The location of your emergency evacuation meeting area.

The Principal Investigator must ensure that all laboratory personnel are familiar with this information.

- Laboratory personnel should be aware of their level of expertise with respect to the use of fire extinguishers and emergency equipment, response to chemical spills, and ability to treat injuries. They should not take actions outside the limits of their expertise, but instead, should call on trained personnel for assistance.

- Post emergency telephone numbers and the telephone numbers of individuals responsible for the laboratory by the laboratory telephone and on signage at the laboratory entrance.

Emergency Procedures:

- Call 911 immediately for all fires and any accidents or spills with injuries that require urgent medical attention.
- Call EH&S at **7-3129** during normal business hours for accidents or spills without injuries or with injuries that **do not require** urgent medical attention. After normal business hours and on weekends and holidays call FAU Campus Police at **7-3500**.
- Emergencies involving radiation or radioactive materials must also be reported to the FAU Radiation Safety Officer at **7-3129**. After normal business hours and on weekends and holidays call FAU Campus Police at **7-3500**.

Table IX General Emergency Procedures

Type of Emergency	Who to Call
All Fires Accidents or Spills with injuries that require urgent medical attention	At Any Time Campus Police or Local Emergency Responders 911

Type of Emergency	Who to Call
Accidents or spills without injuries or with injuries that do not require urgent medical attention (i.e. on-site first aid only)	During Normal Business Hours Environmental Health and Safety 561-297-3129 Outside Normal Business Hours, Weekends, Holidays Campus Police 561-297-3500
Emergencies involving radiation or radioactive materials	During Normal Business Hours Radiation Safety Officer 561-297-3129 Outside Normal Business Hours, Weekends, Holidays Campus Police 561-297-3500

Management of Spills

Hazardous chemical, biological or radiological spills can be handled effectively when a plan of action has been developed. To respond to any type of spill, lab personnel must be adequately trained. Contact **EH&S** for training assistance. Spill awareness and/or procedures include the following:

a. The potential location of spills.

b. The quantities of material that might be released.

c. Chemical, physical and hazardous properties of the material. This information may be obtained from the (Material) Safety Data Sheet or label.

d. The types of personal protection equipment that is needed for cleanup.

e. Location and contents of spill kits that should be made available where possible.

Table X presents a list of *suggested* materials for spill control kits. **Note: Not all the materials on this list are required to complete a spill control kit, only those which apply to a particular laboratory.**

Table X Suggested Items For Laboratory Spill Control Kits

COMPONENTS	QTY[1]	PURPOSE
Plastic Tote	1 each	hold kit contents below
Clay Absorbent (i.e. Oil-Dry, Kitty Litter)	5 lbs.	absorbent for organic solvents, oil spills
Sodium Bicarbonate	5 lbs.	neutralizes acid (base) spills
Magic Sorb®	5 lbs.	all purpose (except Hydrofluoric Acid)
Sodium Hypochlorite (bleach)	1 gal.	disinfectant for biohazardous spills
Absorbent pads/ paper	6 units	absorb radioactive/biohazardous spills
Sulfur	1 lb.	reactant for mercury spills
Mercury "sniffer" bottle	1 each	pick-up mercury droplets
Silver Shield, Nitrile or neoprene coated gloves	2 pairs	PPE
Disposable gloves	1 box	PPE
Safety Goggles	2 pairs	PPE
Whisk broom or bench brush	2 each	collect spill waste
Dustpan (non-sparking)	2 each	collect spill waste
Polyethylene bags	6 each	collect and dispose waste
Impermeable red biomedical waste bags	6 units	dispose biomedical waste
Tongs or forceps	1 each	picking up sharps/syringes
Duct tape	1 roll	seal spill waste in bag
Other (as needed)		

[1]These quantities are suggested amounts per laboratory. Items may be added to or deleted from the spill kit depending on the variety and quantity of chemicals used in a laboratory. Additional items can include absorbent towels, spill pillows, mops, Radiacwash spray, etc.

Simple Chemical Releases

A simple chemical release is generally small in quantity, gradual in dispersion, and easy to contain. Simple releases may be managed with a laboratory spill control kit. The Principal Investigator or the laboratory supervisor must be informed when this type of release occurs. The following are some routine procedures to use with a simple chemical spill:

a. *Neutralize acids and bases whenever possible*. Use baking soda (sodium bicarbonate) or some other appropriate neutralizer. (Never neutralize a spill on skin, use water.)

b. *Control and absorb liquid releases*. Use absorbent materials (Speedi Dri, oil dry, spill socks, pads, etc.) to dike the contaminated areas and prevent the spread of a liquid release.

c. *Store waste absorbent materials properly*. After cleaning the release area, place waste products in a properly labeled container and contact **EH&S** for disposal.

d. *Decontaminate the area and affected equipment*. Increase ventilation to the area by using fans or opening windows if available. Contact **EH&S** for an indoor air quality assessment if necessary.

When dealing with a simple release, make sure to properly label all disposal bags with the names of the spilled chemicals and the approximate amounts. Also include on the label "contains broken glass," where appropriate. Always restock the spill control kit after use.

Complex Chemical Releases

Complex chemical releases require outside assistance from properly trained individuals. These involve the release of large amounts of chemicals or chemicals of high toxicity. Evacuate the area, contact the **Campus or Local Police** and **EH&S**, and have all personnel involved wait in a predetermined evacuation area.

Guidelines for Mercury Handling, Storage, and Spill Cleanup

This guideline, specifically written for mercury, was developed because of the toxicity of the element, and because it is so widely used on the FAU campuses. Mercury is a chronic toxin and particularly insidious due to its long latency period. It is similar to benzene or lead since it is a cumulative poison that produces body damage through exposure to small concentrations over a long period of time.

Elemental mercury can be absorbed through the skin, inhaled as a gas, or ingested. Although it is a liquid at room temperature, it is constantly emitting vapors that are colorless, odorless, and tasteless. Mercury poisoning causes emotional disturbances, unsteadiness, inflammation of the mouth and gums, fatigue, memory loss, and possibly kidney damage.

Handling - All work with mercury should be performed in a properly functioning fume hood. At a minimum, a lab coat and at least one pair of disposable gloves should be worn. Secondary containment should be utilized when transporting or working with mercury.

Storage - Containers of mercury should be kept closed and stored in secondary containers in a well-ventilated room. The secondary container for storage or use, should be enameled or plastic for easy cleaning and large enough to hold the volume of mercury in use.

Spills - Notify everyone in the area that a spill occurred, call **EH&S**.

a. Isolate the area to prevent spreading.
b. A mercury spill kit must be used, and proper procedures followed.
c. At a minimum, wear gloves, lab coat, and shoe covers.
d. Place mercury and mercury device in a bottle or zip lock bag and label.
e. Wash thoroughly after the cleanup is complete.
f. Place bags in the Designated Waste Area and call EH&S for a pickup and a survey.
g. For large spills (barometers, manometers) call EH&S immediately.

The preferred mercury spill cleanup method is to immediately call EH&S for cleanup.

Accidental Release of Biohazardous Agents

Laboratories in which biohazardous agents are used must have the ability to contain and control accidental releases of these agents. The laboratory spill kit must incorporate the appropriate items to accomplish containment including, but not be limited to, the following: an appropriate disinfectant/decontaminate, proper PPE (gloves, goggles, etc.), and **RED** biomedical waste disposal bags. Laboratory procedures and biohazardous agents present in a specific laboratory will determine what additional items may be necessary.

For more information concerning the use and disposal of biohazardous agents, see the *FAU Biological Waste Program*.

Spills of Radioactive Substances

The accidental release of radioactive substances falls into two primary categories:

- *Minor incidents* – Incidents involving the release or spillage of less than 10 uCi of a radionuclide in a non-volatile form.

- *Major incidents* – Incidents involving the release or spillage of greater than 10 uCi of a radionuclide or any amount of a radionuclide in a volatile form.

Minor Incident Procedure:

1. **Notify** all other persons in the area immediately.
2. **Prevent** the spread of contamination by placing absorbent paper on the spill.
3. **Clean** up the spill working from the outside of the spill inward.
4. **Survey** the area, record the results.
5. **Dispose** of all materials as radioactive waste.
6. **Survey** clothes, hands, and feet.
7. **Notify** the laboratory supervisor.
8. **Notify** EH&S and the RSO at 7-3129.

Major Incident Procedure:

1. **Clear** the area of all personnel.
2. **Notify** the RSO immediately at 7-3129.
3. **Notify** the laboratory supervisor.
4. **Close** and lock the lab.
5. **Post** warning signs.
6. **Survey** personnel and area, record results.
7. **Wait** for assistance from RSO before decontaminating area.

Surveys of the area for residual contamination are also required as well as reporting all accidental releases to the Radiation Safety Officer. See the FAU Radiation Safety Manual for more information on managing accidental releases of radioactive materials.

Appendix F: Forms and Checklists

LABORATORY CONTACT INFORMATION*

Scan for CHP

Department: Click or tap here to enter text.

Building / Room #.: Click or tap here to enter text.

Lab Manager/Principal Investigator: Click or tap here to enter text. Phone: Click or tap here to enter text.

Emergency Contact Person: Click or tap here to enter text. Phone: Click or tap here to enter text.

After Hours Phone: Click or tap here to enter text.

EMERGENCY PROCEDURES AND CONTACT INFORMATION

- Call **911** immediately for all fires and any accidents or spills with injuries that require urgent medical attention.

- Call EH&S at **7-3129 (561-297-3129)** during normal business hours for accidents or spills without injuries or with injuries that **do not require** urgent medical attention. After normal business hours and on weekends and holidays call FAU Police at **7-3500 (561-297-3500)**.

- Emergencies involving radiation or radioactive materials must be also reported to the FAU Radiation Safety Officer at **7-3129 (561-297-3129)**. After normal business hours and on weekends and holidays call FAU Police at **7-3500 (561-297-3500)**.

GENERAL EMERGENCY PROCEDURES

Type of Emergency	Who to Call
All Fires Accidents or Spills **with injuries that require** urgent medical attention	**At Any Time** Local Emergency Responders **911**
Accidents or spills **without injuries or with injuries that do not require** urgent medical attention (i.e. on-site first aid only)	During Normal Business Hours Environmental Health and Safety **7-3129 (561-297-3129)** Outside Normal Business Hours, Weekends or Holidays FAU Police **7-3500** (561-297-3500)
Emergencies involving radiation or radioactive materials	During Normal Business Hours FAU Radiation Safety Officer **7 -3129** (561-297-3129) Outside Normal Business Hours, Weekends, Holidays FAU Police **7-3500** (561-297-3500)

Non- Emergency Safety Hazard	
For EH&S Safety Hazard and/or Near Miss, using your smartphone or tablet scan QR Code and complete form	**SCAN TO REPORT A HAZARD**

* Fill in appropriate information and post on entry door to laboratory and next to the laboratory phone, if one is present.

Laboratory Safety Inspections – Detailed Review Items
Revision 01/21/2021

- **Chemical Storage & Safety**
  - Chemical containers properly labeled, stored, & closed when not in use.
  - Chemicals segregated and stored by compatibility.
  - Peroxide formers dated at purchase and again upon opening.
  - Peroxide formers disposed of within proper time frames.
  - Secondary containment used where appropriate.
  - Vacuum equipment trapped and/or filtered.
  - Chemical storage areas free of ignition sources.
  - Refrigerators/Freezers properly labeled.
  - Refrigerators/Freezers properly rated if flammable liquids are stored within.
  - Fume hoods and/or biosafety cabinets not used for general storage.
  - Cryogenic materials stored properly and proper PPE available.
  - Corrosive storage cabinet used if more than 10 gal of corrosives present.
  - Chemicals purchased in amounts that can be used within a reasonable time.
  - Chemical stocks purged of old, outdated, and unusable chemicals.
  - Chemical inventory up to date.
- **Compressed Air and Compressed Gases**
  - Air compressors equipped with pressure gauges and pressure relief valves.
  - Compressed air piping, hoses and fittings in good condition.
  - Compressed air 30 psi or less for machine/parts cleaning, 10 psi for clothing.
  - Compressed air cleaning nozzles with chip/particle deflection device.
  - Gas cylinders w/30 lb or more water capacity have valve protection capability.
  - Gas cylinders legibly marked as to their contents.
  - Gas cylinders stored away from high heat, flames, etc.
  - Gas cylinders stored in secure area and secured from tipping or falling.
  - Gas cylinders transported on cylinder carts.
  - When in use, gas cylinders kept away from elevators, stairs, and ramps.
  - Valve protectors used when cylinders not in use or when being transported.
  - Liquefied gas cylinders (acetylene) stored valve-end up.
  - Proper type of regulator used for type of gas cylinder in use.
  - Gas cylinders, valves, couplings, regulators kept free of oil and grease.
  - Gas cylinders lacking obvious defects, leaks, damage, etc.
  - Gas cylinders hydrotested at appropriate intervals.
  - Empty gas cylinders labeled "Empty," valves closed, and caps on.
  - Oxygen and Acetylene in storage are separated by 5' noncombustible barrier.
- **Hazardous Waste & Materials Disposal and Recycling**
  - Waste storage areas (bins, totes) designated.
  - Waste containers properly labeled (chemical components, amounts, etc.).
  - Waste containers compatible with waste to be stored.
  - Only compatible chemical wastes stored in the same container.
  - Waste containers kept closed except when adding waste.
  - Waste containers stored by compatibility.
  - Used oil collected and recycled properly.

- Non-alkaline batteries (lead acid, Ni-cad, silver, etc.) managed for recycling.
- Mercury containing devices (lamps, thermostats, barometers, etc.) properly recycled.
- Electronic devices, (monitors, TVs, circuit boards, etc.) managed properly.
- Biohazardous materials & animal carcasses managed & disposed properly.

- **Manuals, Training, SOPs, MSDSs, Occ. Health**
  - Appropriate safety manual(s) available (CHP, ECP, Bio Safety, Animal Research HASP, Rad Safety, etc.).
  - Standard Operating Procedures & Material Safety Data Sheets readily available.
  - Applicable initial/refresher training completed. (LS,HW,BW,BBP, RAD,etc.).
  - Personnel in occ. health program, if required (blood, etiologic agents, carcin.).
- **Safety Equipment and Emergency Preparedness**
  - Eyewash & safety shower within 100 ft. and 10 second travel time.
  - Eyewash & safety shower unobstructed and inspected as required.
  - Fume hoods, biosafety cabinets, glove boxes, properly located and certified.
  - Appropriate spill control kit available and stocked (Chem, Rad, Bio).
  - Spill & accident reporting procedures understood by lab personnel.
  - Appropriate first aid kit available and stocked.
  - Emergency contact information posted by entrance (and by phone if present).
- **Electrical Safety**
  - Extension cords are not used as permanent wiring.
  - Extension cords and power strips not daisy-chained one to another.
  - Electrical cords not under carpets/rugs, through doorways, or high traffic areas.
  - Multi-outlet power strips are UL listed and have circuit breakers.
  - Power cords are in good condition with no splices or broken insulation.
  - Grounding prongs not removed from 3-way plugs.
  - Outlet, switch and junction box covers are in place and in good repair.
  - Circuit breaker panels and emergency shut offs unobstructed and labeled.
  - Electrical outlets not overloaded with appliances, i.e. splitters used.
  - Ground Fault Interrupters installed, labeled and operating correctly.
  - Energized parts, circuits, and equipment guarded against accidental contact.
- **Fire Prevention and Protection**
  - Fire extinguishers properly mounted, located, and identified.
  - Fire extinguishers adequate in number and type.
  - Fire extinguishers inspected, recharged, and maintained as required.
  - Fire aisles, exitways, stairways, and fire equipment kept unobstructed.
  - Exit lights properly illuminated and emergency lighting operable.
  - Fire doors not blocked open or are on magnets connected to fire alarm system.
  - Flammable liquids stored in approved safety cans.
  - Flammable liquid containers kept closed when not in use.
  - Flammable liquids of 10 gallons or more stored in flammable storage cabinet.
  - Flammable storage cabinets labeled "Flammable - Keep Fire Away."
  - Connections on drums and combustible liquid piping leak free.
  - Flammable liquid drums grounded and bonded to containers when dispensing.
  - Oily/greasy rags placed in proper self-closing oily rag containers.
  - No penetrations through walls or ceilings and all ceiling tiles are in place.
  - Sprinkler heads clean and no storage within 18 inches.
  - Sprinkler heads protected by metal guards when exposed to physical damage.

- **General & Miscellaneous Safety**
    - Hand washing sink, soap and towels available & used before leaving lab.
    - Sink faucets with backflow device or attached hoses above sink rim.
    - Heavy objects stored below 5 ft. unless secured and stepladder provided.
    - Stepladder or stepstool available & in good condition for high storage access.
    - Appropriate signs posted (First aid kit, safety shower, fire extinguisher, etc.).
    - Proper handling & disposal of broken glass & sharps.
    - Batteries charged in properly ventilated area away from sparks and flames.
    - Work practices observed during inspection done safety.
    - No food or beverages unless adequately separated from hazard areas.
    - Benchtops impervious to water and resistant to chemicals.
    - Lab furniture is appropriate for loading and use.
- **General Work Environment & Indoor Air Quality**
    - All areas properly illuminated. Glare and reflections avoided.
    - Noise levels are within acceptable limits or engineering controls established.
    - Areas with high noise levels posted and hearing protection required to be used.
    - Work areas clean, sanitary, and orderly. (garbage disposed properly, etc.)
    - Work area properly ventilated for type of equipment or chemicals in use.
    - Vacuum systems used when possible instead of blowing or sweeping dusts.
    - Temperature and humidity seem to be within acceptable ranges.
    - Areas free of visible fungal/mold growth and associated odors.
    - Walls ceilings, floors free of signs of mold or moisture damage.
    - Air intake areas free of odor causing materials or hazardous chemicals.
- **Personal Protective Equipment (PPE)**
    - Appropriate eye/face protection is available and used if hazard present.
    - Appropriate hand protection is available and used if hazard present.
    - Appropriate hearing and foot protection available and used if hazards present.
    - Protective clothing - coveralls, aprons, gowns, etc. available & used if needed.
    - Protective clothing and gloves removed before leaving lab.
    - Non-disposable protective clothing laundered on site or by commercial service.
    - Approved respirators available and used if needed.
    - Respirator users medically certified, properly trained and fit tested.
    - PPE is properly stored, clean and in good condition.
- **Animal Biological Safety Level 2**
    - Personnel are enrolled in the Occupational Health Program.
    - Human allergies to animals have been addressed.
    - If animals are taken from the animal care facility & used in the lab, how long?
    - Project has been approved by the IACUC.
    - Floor drain traps filled with disinfectant.
- **Biological Safety Level 2**
    - Lab access restricted when working with infectious agents.
    - Appropriate Biological Safety Level sign posted.
    - Lab personnel advised of hazards and required immunizations.
    - Lab personnel receive appropriate immunizations & tests for agents handled.
    - Baseline serum collected, if appropriate.
    - Specimen containers leakproof and covered during transport.
    - Equipment & work surfaces disinfected regularly, after work with agents or spills.

- Work has been approved by the IBC.
- Access restricted to Select Agents and Select Agents properly secured.
- All spaces accessible for cleaning and are easily cleaned. No carpets or rugs.
- Insect and rodent control program in place.
- Biosafety Cabinet (Class II) or other containment device used when appropriate.
- Centrifuge safety caps/cups are utilized.
- Mechanical pipetting devices are utilized.
- Autoclave log available (Temp. monitoring, BI monitoring etc.)
- Autoclave efficacies are verified & documented.
- Plasticware and safer needle alternatives implemented where feasible.

- **Biological Safety Level 2+**
  - BSL 3 Standard practices, special practices, and safety equipment in use.
  - Laboratory is under negative pressure with respect to other areas.
  - Exhaust air is discharged to the outside of the building.
  - Hands-free/automatic handwashing sink provided near exit door.
  - Vacuum lines protected with liquid disinfectant traps and HEPA filters.
- **Radiation Safety**
  - Room is authorized by FAU's State of Florida Radioactive Materials License
  - Caution, Radioactive Material signs posted on entrance doors
  - Equipment, containers, & storage areas properly labeled
  - Emergency procedures posted
  - Notice to Employees (Form DH-1081) posted.
  - EH&S Waste Guidelines posted
  - Radioactive material secured against unauthorized access/removal
  - Appropriate shielding of radioactive materials
  - Radioactive material users have received initial training
  - Radioactive material users have received refresher training
  - Inventory records are maintained for 3 years
  - Survey records are maintained for 3 years
  - Survey instrument available
  - Survey instrument calibrated within the last year
  - Liquid Scintillation Counter calibrated annually
  - Waste is properly labeled and shielded
  - Removable contamination surveys performed as required
  - Radiation level surveys performed at required frequency
  - Radioactive materials users wear appropriate PPE
  - Fume hood functioning properly
  - Individuals wear whole body TLDs as required
  - Individuals wear extremity TLDs as required
  - No evidence of eating, drinking, or applying cosmetics
  - No storage of food, drink, or personal effects in restricted area
  - No radioactive contamination detected
  - Radiation levels less than 2 mR in any one hour

FLORIDA ATLANTIC UNIVERSITY

Laboratory Disaster Preparedness Checklist

- ☐ Store reactive chemicals in waterproof containers. Potentially hazardous reagents should be over-packed in plastic and stored in waterproof containers.
- ☐ Store volatile and toxic materials in tightly sealed, break resistant containers.
- ☐ Remove volatile and toxic materials from the fume hoods and open lab spaces.
- ☐ Close fume hood and biosafety cabinets sashes.
- ☐ Store laboratory research data, laboratory notebooks and other important documentation in a waterproof container.
- ☐ Remove glassware from bench tops.
- ☐ Remove chemicals from benchtops.
- ☐ Back-up electronic data.
- ☐ Use dry ice to store items that need refrigeration.
- ☐ Fill Dewar's and/or cryogen containers for sample storage, if available.
- ☐ Dispose of hazardous and biological waste. Contact EH&S a minimum of 48 hours prior.
- ☐ Inactivate rDNA or infectious material, where applicable (i.e. autoclave, disinfect etc.)
- ☐ Store and secure rDNA or infectious material appropriately.
- ☐ Turn off and unplug appliances, hotplates, ovens and other equipment.
- ☐ Turn freezers and refrigerators to lowest possible setting and plug into available APC or equivalent emergency power supply unit.
- ☐ Plug active incubators into available APC or equivalent emergency power supply unit. (if there is an active/ in-progress experiment)
- ☐ Using plastic, cover and secure laboratory equipment
- ☐ Make alternative arrangements for the care for animals. Discuss with Vet staff and refer to specific vet emergency plan.
- ☐ Secure biohazard agents to prevent the potential release into the environment.
- ☐ Secure radioactive isotopes to prevent the potential release into the environment.
- ☐ Secure recombinant materials to prevent the potential release into the environment.
- ☐ Remove regulators and cap gas cylinders.
- ☐ Closed all gas cylinder valves.
- ☐ Shut off gas supply where applicable.
- ☐ Secure all cylinders well.
- ☐ Close and/or secure lab cabinets, filing cabinets and cupboards.
- ☐ Close and/or secure laboratory windows.
- ☐ Lock all laboratory doors before leaving.
- ☐ Ensure the PI/Lab manager emergency contact sheet is update and posted on the outside of the laboratory door.

☐ Ensure hazard warning information is up to date on laboratory signage posted on the outside of the laboratory door.

Appendix G: Glossary

Laboratory employees should become familiar with the following terms and concepts. Many of these terms are commonly used in Safety Data Sheets (SDSs). Some are also found in this Chemical Hygiene Plan.

ACGIH. **A**merican **C**onference of **G**overnmental **I**ndustrial **H**ygienists. An organization of professionals in government agencies and educational institutions engaged in occupational safety and health programs.

Aqueous. Describes a water-based solution or suspension. Frequently describes a gaseous compound dissolved in water.

Anhydride. Any compound formed by the removal of the elements of water (hydrogen and oxygen).

Anhydrous. "Without water". A substance in which no water molecules are present either in the form of a hydrate or as water of crystallization.

ANSI. **A**merican **N**ational **S**tandards **I**nstitute. A privately funded, voluntary organization which develops and coordinates national consensus standards. Many ANSI standards relate to safe design/performance of equipment and safe practices or procedures. ANSI standards are widely recognized and accepted as "State of the Art" knowledge regarding acceptable safety practices.

Asphyxia. The loss of consciousness as a result of too little oxygen and too much carbon dioxide in the blood.

Asphyxiate. A vapor or gas that can cause unconsciousness or death by suffocation. Most *simple asphyxiants* are harmful to the body only when they become so concentrated that they reduce the available oxygen in the air (normally about 21 %) to dangerous levels (18 % or lower); e.g., CO_2, N_2, H_2 and He. Others are *chemical asphyxiants* like carbon monoxide (CO) or hydrogen cyanide (HCN) which reduce the blood's ability to carry oxygen.

Autoignition temperature. The minimum temperature to which a substance must be heated without application of a flame or spark to cause that substance to ignite. Materials should not be heated to greater than 80% of this temperature.

Base. A substance that can do at least one of the following: (1) liberate hydroxide anions (OH^-) when dissolved in water, (2) receive a hydrogen ion from a strong acid to form a weaker acid, and/or (3) give up two electrons to an acid. Bases have a pH > 7 and turn litmus paper blue. They may be corrosive to human tissue and should be handled with care.

Biodegradable. The capability of being readily decomposed by biological means, especially by microorganisms.

Biomedical waste. Any solid or liquid waste which may present a threat of infection to humans.

Biomedical waste disposal bags (red bags). These are the only approved biomedical waste disposal bags used at FAU to be in compliance with FAC 64E-16. All other types are illegal in the state of Florida. Supplies of these bags can be obtained from private distributors or through **EH&S**.

Bloodborne Pathogens Policy and Procedures. The University's Exposure Control Plan, designed to eliminate or minimize occupational exposure of employees to bloodborne pathogens and other potentially infectious materials in compliance with OSHA's Bloodborne Pathogens Standard 29 CFR 1910.1030.

Boiling point, BP. The temperature at which the vapor pressure of a liquid is equal to the surrounding atmospheric pressure so that the liquid becomes a vapor. Flammable materials with low BP's generally present special fire hazards. e.g., butane, BP = 31 ^{o}F; gasoline, BP = 100 ^{o}F.

BTU. British **t**hermal **u**nit. The quantity of heat required to raise the temperature of 1 lb of H_2O by 1 ^{o}F at 39.2 ^{o}F, its temperature of maximum density.

Buffer. A substance that reduces the change in hydrogen ion concentration (pH) that otherwise would be produced by adding acids or bases to a solution.

Carcinogen. Substances that can cause cancer in humans or animals. A material is considered to be a carcinogen if (1) it has been evaluated and listed by the International Agency for Research on Cancer (IARC), (2) it is listed as a carcinogen or suspected carcinogen in the Annual Report on Carcinogens published by the National Toxicology Program (NTP), (3) it is regulated by OSHA as a carcinogen, or (4) it meets the EPA criteria for a carcinogen or suspected carcinogen.

CAS Registration Number. Chemical **A**bstract **S**ervice registration number is the number assigned to identify a substance. CAS numbers identify *specific* chemicals and are assigned sequentially. The numbers have no chemical significance.

CFR. Code of Federal Regulations. The annual accumulation of executive agency regulations that contains the general body of regulatory laws governing practices and procedures performed by federal administrative groups.

Combustible. A term used by NFPA, DOT, and others to classify, based on flash point, certain liquids that will burn.

Corrosive. A chemical that causes visible destruction or irreversible alterations in living tissue through chemical action at the site of contact.

Cryogenic. Relating to extremely low temperature such as in refrigerated gases.

DEP. The **D**epartment of **E**nvironmental **P**rotection of the State of Florida. A state agency with environmental protection, regulatory, and enforcement authority.

Dermal toxicity. Adverse effects resulting from skin exposure to a material. Ordinarily used to denote effects on experimental animals.

DOT. U.S. **D**epartment **O**f **T**ransportation. Regulates transportation of materials. DOT addresses issues in labeling, weight, classification of hazards, placarding of vehicles, etc. DOT regulations are intended to protect the public as well as fire rescue, EMTs and other emergency-response personnel.

Designated Area. A separate and distinct portion of a laboratory designed to deal with extremely hazardous chemicals and other substances that require special needs. The Designated Area must have the necessary engineering controls (fume hoods, biosafety cabinets, etc.) and the appropriate warning labels. Access must also be strictly controlled. A Standard Operating Procedure detailing the methods, responsible individuals, materials and handling of substances in the Designated Area must be completed by the Principal Investigator, and approved by **EH&S**.

Electrolyte. Any substance which in solution or in a liquid form is capable of conducting an electric current by the movement of its disassociated positive and negative ions to the electrodes.

EPA. U.S. **E**nvironmental **P**rotection **A**gency. The federal agency with environmental protection, regulatory, and enforcement authority.

Evaporation rate. The rate at which a material will vaporize from the liquid or solid state. The evaporation rate can be useful in evaluating the health and fire hazards of a material.

Exposure limits. The boundaries for quantities of chemicals to which employees can be exposed.

Flammable. Describes any solid, liquid, vapor or gas that will readily catch fire and burn in air.

Flash point. The lowest temperature at which a liquid has a sufficient vapor pressure to form an ignitable mixture with air near the surface of the liquid.

Freezing point. The temperature at which a material changes its physical state from liquid to solid.

Hazardous material. Any substance or mixture of substances having which has properties capable of producing adverse effects on the health or safety of a human. These substances also display the characteristics stated in 40 CFR 261.3, Subpart D, of ignitability, corrosivity, reactivity and EPA Toxicity or are listed in 40 CFR 261.31-33.

HEPA. Acronym for **H**igh-**E**fficiency **P**articulate **A**ir-purifying filter equipment, used for removing airborne materials. Often used for the removal of infectious microbes (e.g., TB) from the air.

Incompatible. Describes materials that can cause dangerous conditions when mixed together or stored in close proximity.

Irritant. A non-corrosive material which causes a reversible inflammatory effect on living tissue at the site of contact. The severity of the reaction is a function of concentration and duration of exposure.

LEL. **L**ower **E**xplosive **L**imit refers to the minimum concentration (by percent volume) of a fuel (vapor) in air at which a flame is propagated when an ignition source is present.

Melting point. The temperature at which a solid changes to liquid.

(M)SDS. (**M**aterial **S**afety **D**ata **S**heet. These sheets contain descriptive safety information concerning the use and handling of chemicals. OSHA has established guidelines for these forms (OSHA form 174) and requires those who produce, distribute, and use hazardous materials to make the MSDS available to their employees. *In 2012, the acronym 'MSDS' was simplified to 'SDS', which stands for Safety Data Sheet – see the definition of SDS for more information.*

Mutagen. A material that induces genetic changes (mutations) in the DNA of chromosomes.

Nanomaterial. Engineered nanoscale materials or nanomaterials are materials that have been purposefully manufactured, synthesized, or manipulated to have a size with at least one dimension in the range of approximately 1 to 100 nanometers and that exhibit unique properties determined by their size.

Nanoparticle. An ultrafine particle with lengths in two or three dimensions greater than 0.001 micrometer (1 nanometer) and smaller than about 0.1 micrometer (100 nanometers) and which may or may not exhibit a size-related intensive property.

NFPA. **N**ational **F**ire **P**rotection **A**ssociation. A national organization with the purpose of establishing programs, standards and safeguards against loss of life and property by fire. The NFPA develops the National Fire Codes that are the laws that govern fire prevention and protection.

NIOSH. **N**ational **I**nstitute of **O**ccupational **S**afety and **H**ealth. The agency of the Public Health Service that tests and certifies respiratory and air sampling devices. It recommends exposure limits for substances and assists OSHA in investigations and research.

Odor threshold. The lowest concentration of a gas in air that can be detected by smell.

OSHA. The **O**ccupational **S**afety and **H**ealth **A**dministration. Part of the U.S. Department of Labor. The regulatory and enforcement agency responsible for safety and health in most U.S. industrial sectors.

Oxidation. A reaction in which a substance combines with oxygen provided by an oxidizer or oxidizing agent. Also the process by which electrons are removed from atoms or ions.

Oxidizer. A substance that yields oxygen readily to stimulate the combustion (oxidation) of organic matter.

pH. The value that represents the acidity or alkalinity of an aqueous solution. The number represents the base 10 logarithm of the reciprocal of the hydrogen ion concentration of a solution.

Physical state. The condition of a material; i.e., solid, liquid, or gas, at a given temperature.

Reducing agent. A chemical or substance that (1) has oxygen removed or (2) gains electrons from an oxidation-reduction reaction.

REL. **R**ecommended **E**xposure **L**imit. The NIOSH, REL, is the highest allowable airborne concentration that is not expected to injure a worker. It may be expressed as a ceiling limit or as a time-weighted average for 10-hr work shifts.

SDS. Safety **D**ata **S**heet. The information contained in the SDS is largely the same as the MSDS, except now the SDSs are required to be presented in a consistent user-friendly, 16-section format. The SDS must be in English (although it may be in other languages as well). In addition, OSHA requires that SDS preparers provide specific minimum information as detailed in Appendix D of 29 CFR 1910.1200.

Sensitizer. A material to which there is little or no physiological response on first exposure in humans or test animals. However, repeated exposures may cause a marked response not necessarily limited to the contact site. The skin and respiratory tracts are the most commonly affected areas in the body by chemical sensitizers.

Sharps container. A rigid, puncture-resistant container designed primarily for containment of needles, syringes, lancets, razor blades, etc. All sharps containers must be labeled with international biohazard symbol. All sharps containers must be approved by **EH&S**.

Standard Operating Procedure (SOP). Procedures which outline the methods, responsible individuals, materials and handling of hazardous and toxic substances in a specialized area in the laboratory. An SOP is specifically required when using extremely hazardous chemicals and/or some types of infectious agents.

Specific gravity. The ratio of the mass of a body to the mass of an equal volume of water at 4^{o}C or other specified temperature.

Target organs. Organs within the body which are specifically affected by different types of chemicals. The most common of these include the liver, kidneys, nervous system, skin, and eyes.

TC_{Lo}. Toxic **C**oncentration **L**ow. The lowest concentration of a substance in air to which humans or animals have been exposed for any given period of time that has produced (1) toxicity, (2) tumorigenesis, or (3) reproductive changes.

TLV. Threshold **L**imit **V**alue. A term used by ACGIH to express the daily exposure limit for workers to the airborne concentrations of specified materials without adverse effects. ACGIH expresses TLV's in three ways: (1) **TLV-TWA**, the allowable **T**ime-**W**eighted **A**verage concentration for a normal 8-hour workday or 40-hour week; (2) **TLV-STEL**, the **S**hort **T**erm **E**xposure **L**imit or maximum concentration for a continuous exposure period of 15 minutes (with a maximum of four such periods per day, and provided that daily TLV-TWA is not exceeded); and (3) **TLV-C**, **C**eiling, the concentration that should not be exceeded at any time.

Toxic. Describes the ability of a material to injure biological tissue.

UEL. Upper **E**xplosive **L**imit refers to the highest concentration (by percent volume) of a fuel (vapor) in air at which a flame is propagated when an ignition source is present.

Vapor pressure. The pressure at any given temperature of a vapor in equilibrium with its solid or liquid form. Vapor pressures are useful (with evaporation rates) to determine how quickly a material becomes airborne and thus how quickly a worker can be exposed to it.

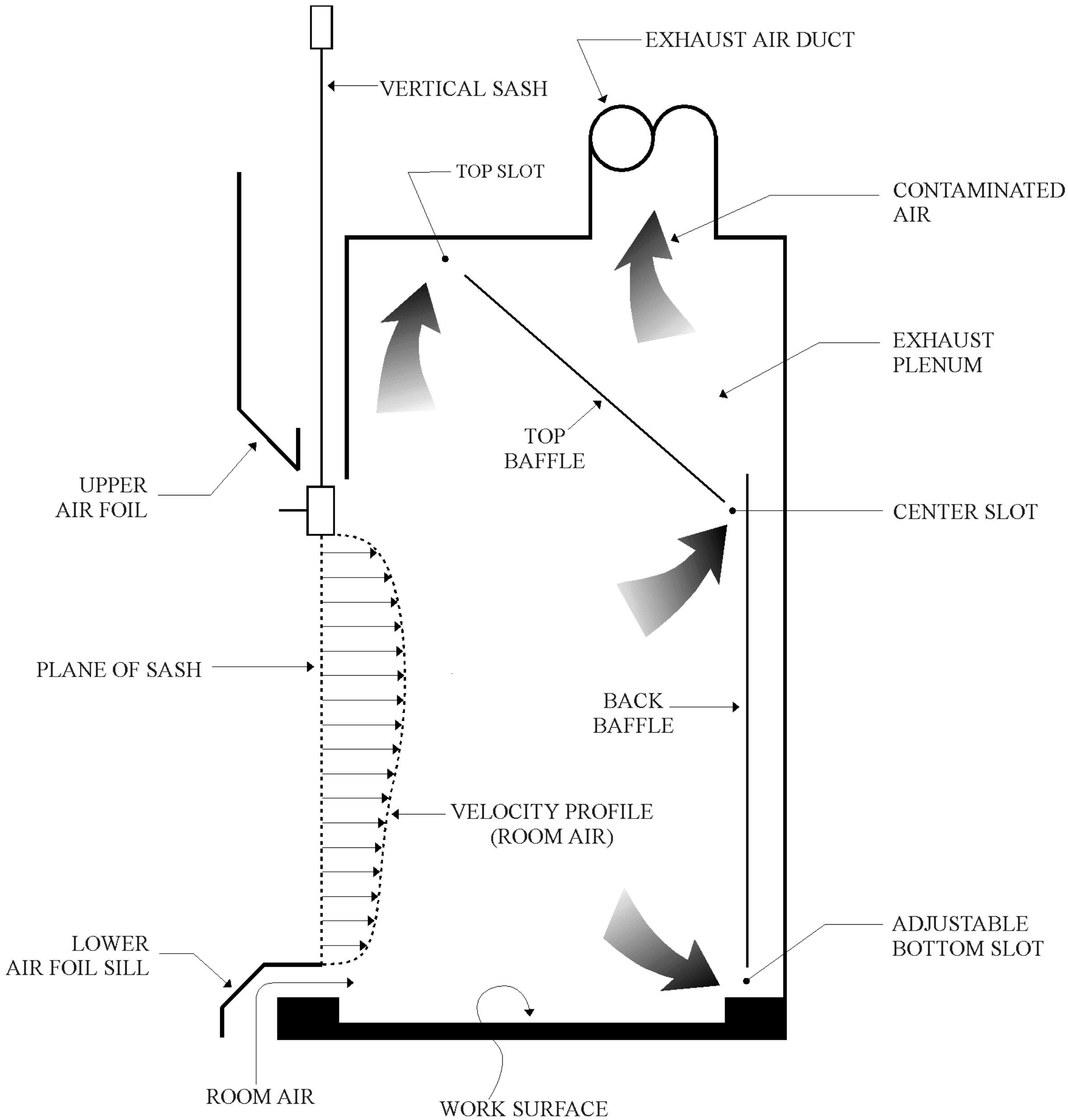
Volatility. Measure of a material's tendency to vaporize or evaporate at ambient conditions.

Water reactivity. Ability of a material to react with water and release a gas that is either flammable or presents a health hazard.

Appendix H: Diagrams of Local Exhaust Devices

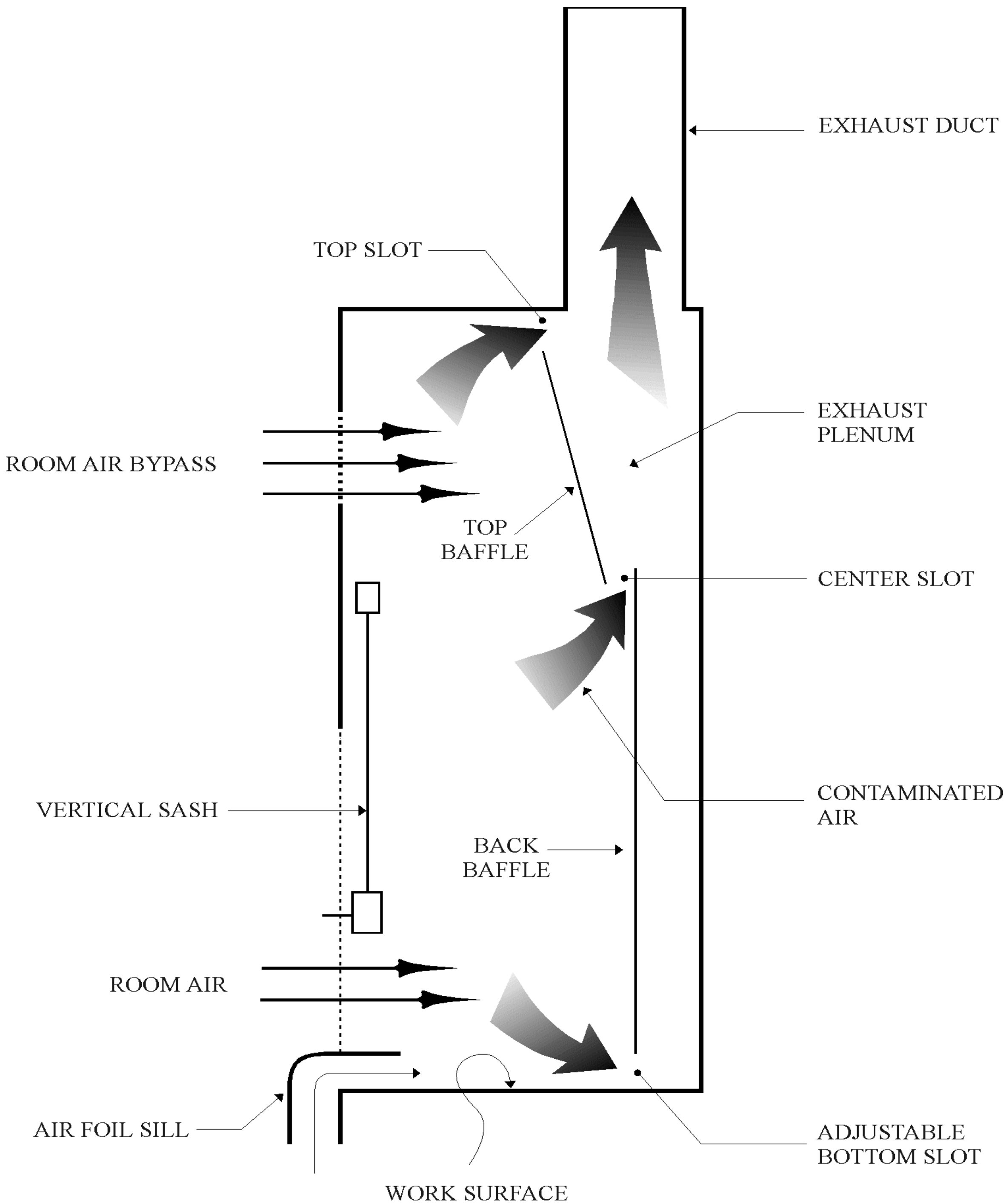
Chemical Fume Hoods

Conventional Fume Hood



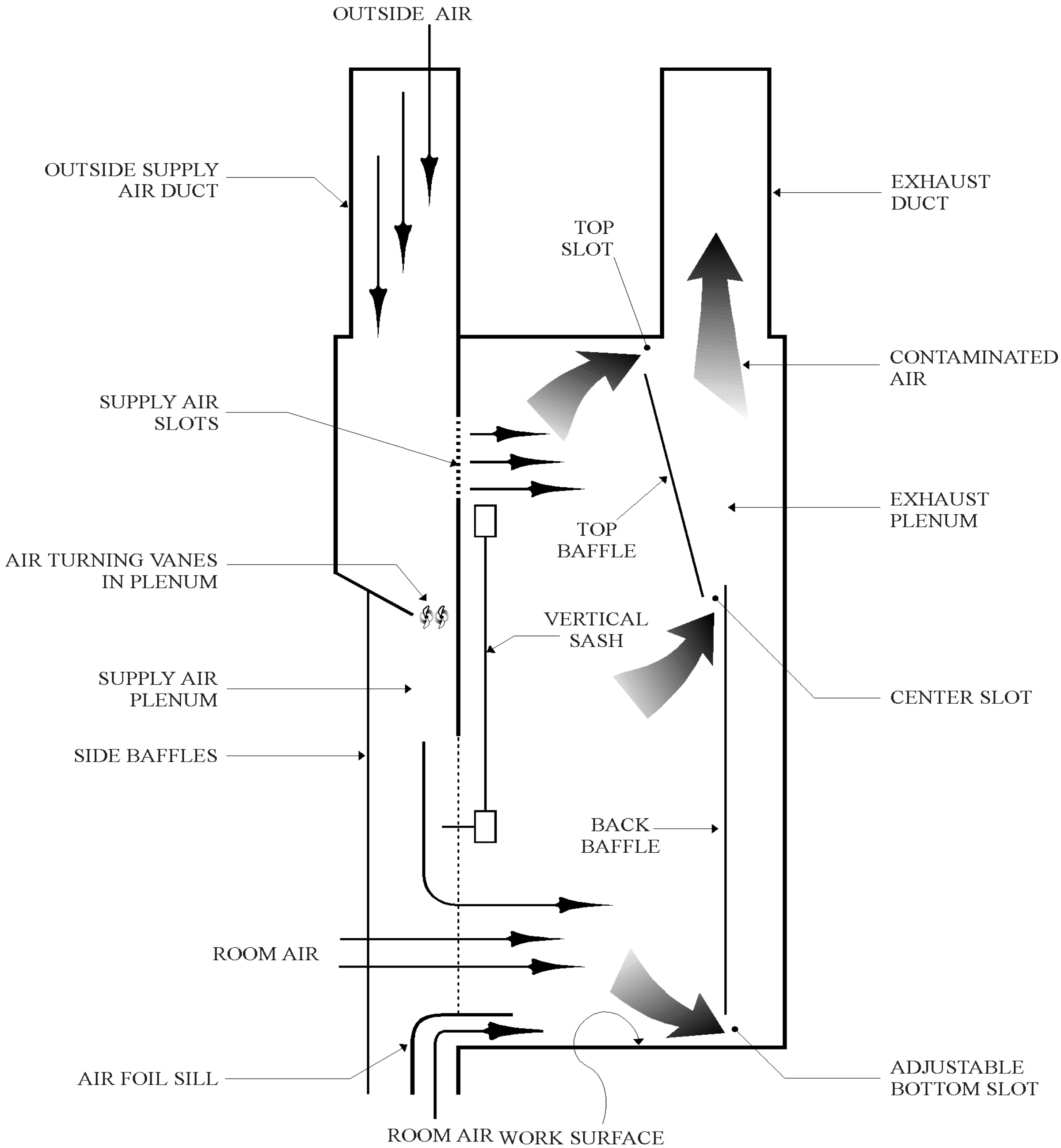
This is the basic fume hood model. Room air is drawn into the hood through the plane of the sash and exhausted through ductwork outside the building. The vertical sash determines the air velocity measured in lfpm (linear feet per minute). The air is exhausted through three (or more) slots (top, center, and bottom) to accommodate a variety of research activities.

Bypass Fume Hood



This type of fume hood is designed to minimize the excessive air velocities which occur when the vertical sash opening is low (6 in. or less). Airflow can be diverted through the room-air bypass at low sash openings which decreases the turbulence created by the increased velocities without effecting the efficiency of the fume hood. These hoods are generally used with experiments involving delicate procedures and/or sensitive equipment.

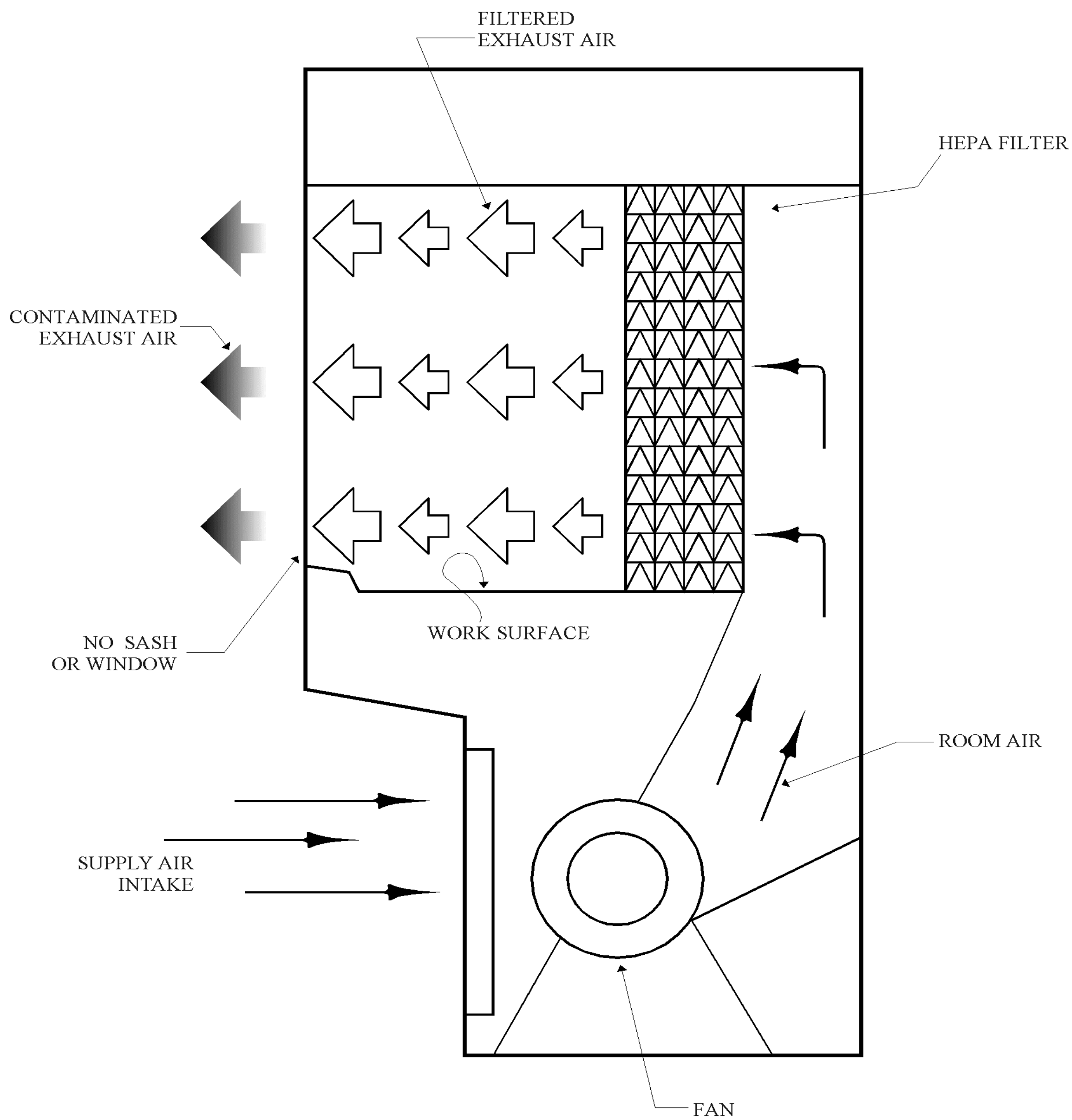
Auxiliary-Air Fume Hood



This type of fume hood is similar to the bypass chemical fume hood except that a major portion of the air exhausted is provided from a supply-air plenum attached to the hood just above the face. The purpose of an auxiliary-air fume hood is to reduce the demand for fully conditioned make-up air for hood service. Since the plenum provides streams of minimally conditioned outside air across the face of the hood, users sometimes mistake these airflows as problems with the exhaust of the hood.

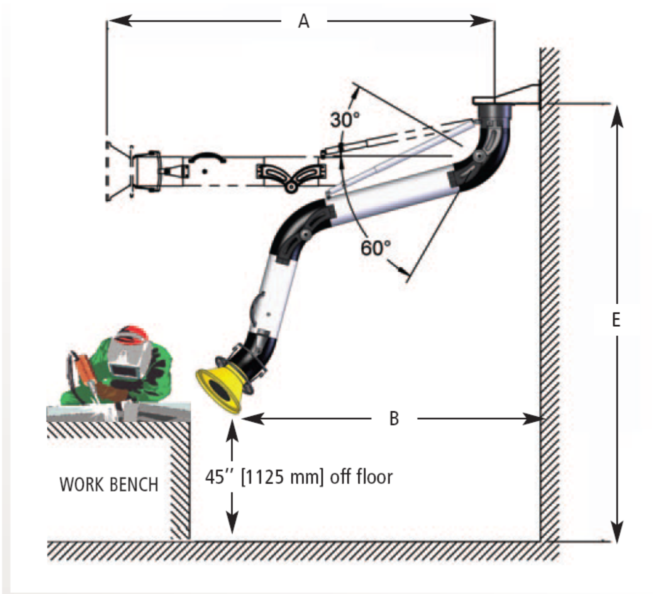
Laminar Flow Hoods

Horizontal Laminar Flow Hood



These devices are termed "laminar flow" because they provide a uniform non-mixing air stream through a HEPA filter. They can also be called "clean benches" because they provide a near sterile work area. Since users will be directly exposed to non-purified air during operation**, these hoods must not be used with toxic, allergenic, or infectious materials**. Laminar flow hoods are designed to protect the product or sample from contamination, not the operator.

Snorkels



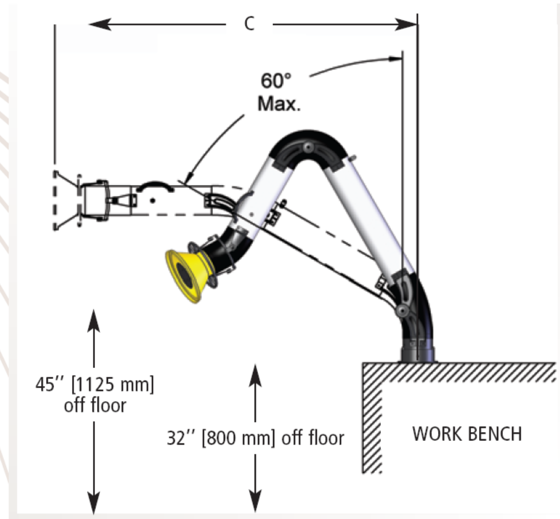
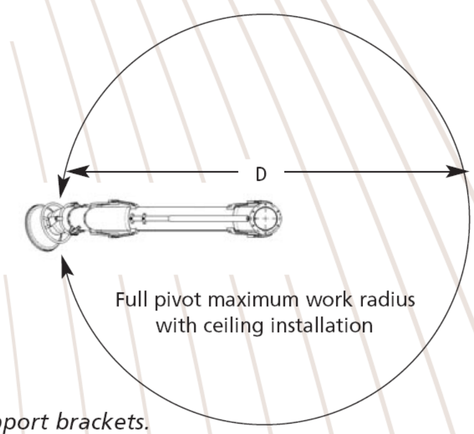


CHART 9

A Arm length [feet] / [m]	B Maximum reach at 45" off floor [feet] / [m]	C Maximum reach at 45" off floor [feet] / [m]	D Maximum reach at 45" off floor [feet] / [m]	E Recommended mounting height [feet] / [m]
3 / 0.9	2.6 / 0.7	3 / 0.9	5.2 / 1.4	6 / 1.5
5 / 1.5	3.5 / 1.1	5 / 1,5	7 / 2.2	6 / 1.5
7 / 2.1	5.5 / 1.7	7 / 2.1	11 / 3.4	6 / 1.5
8.5 / 2.6	7.4 / 2.2	7 / 2.6	14.8 / 4.4	8 / 2.4
10 / 3	8.5 / 2.6	7.8 / 2.4	17 / 5.2	8 / 2.4
14 / 4	11.2 / 3.4	10.2 / 3.2	22.4 / 6.8	8 / 2.4



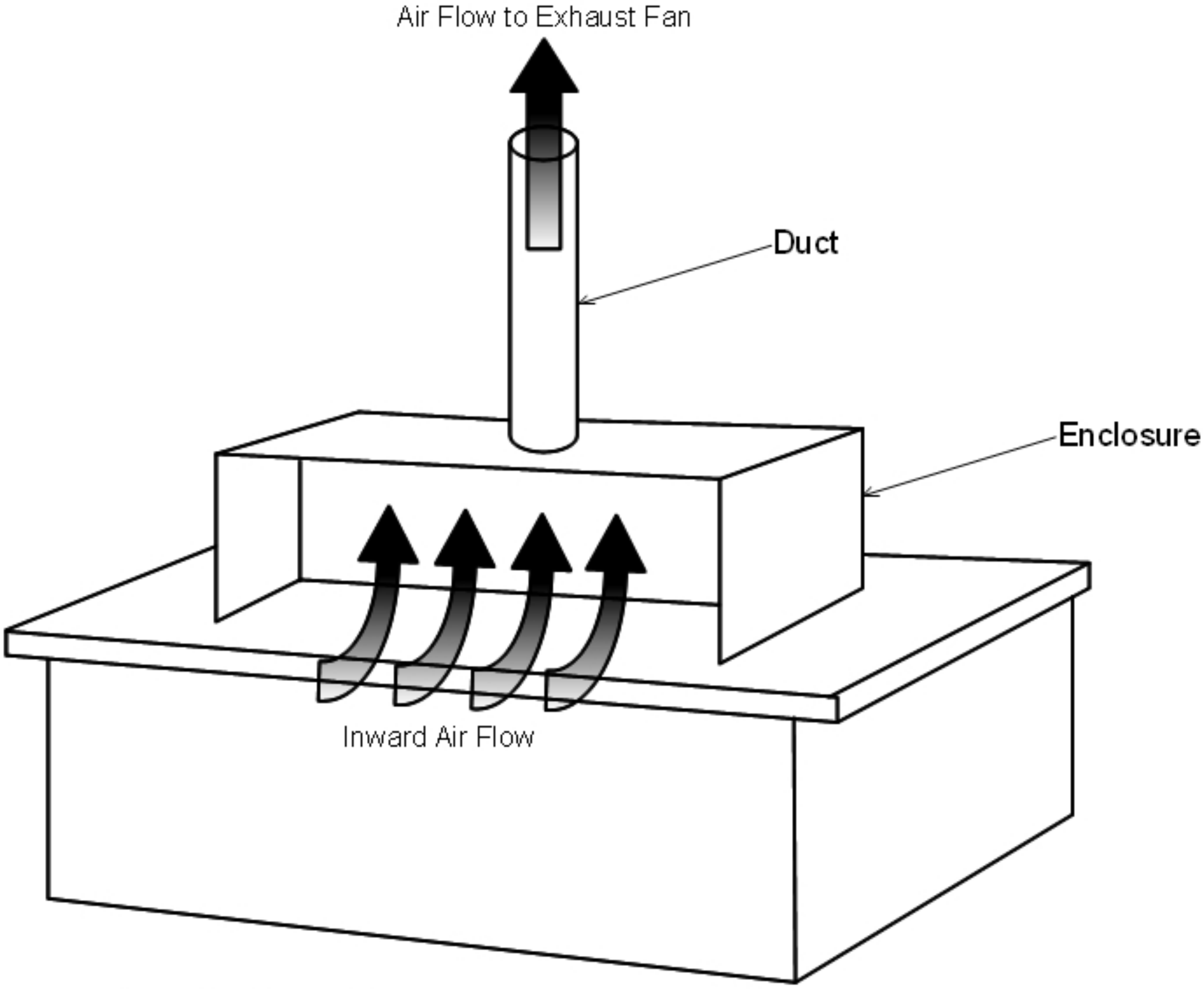
Note on 14' (4 meters) long arms: reaches indicated in chart 9 are with WBF support brackets.

Standard snorkel tubes are usually made of steel with external cast aluminum joints, which may include adjustable friction discs. The arms typically have a handle attached to the hood to facilitate positioning. Aluminum hood diameters can vary from a few inches to more than a foot in diameter. Hood diverters, which increase capture velocity, might also be installed on some models. The effective capture radius for snorkels is generally equal to one hood diameter from the edge of the hood, with efficiency falling rapidly as distance from the hood increases.

This type of local exhaust device is only appropriate for use with low-hazard materials and is not an adequate substitute for higher-efficiency control devices that must be used when working with moderate-to high-hazard materials.

Note: The diagram provided above is for a MAXAIR "Fume Arm" and is typical of the type of laboratory snorkels in use at FAU.

Local Exhaust Enclosures



Local Exhaust Enclosure

At FAU, these enclosures can be found primarily in chemistry laboratories. They are custom made and of metal construction. They have one central pickup area in the center of the enclosure that corresponds to the location where the ductwork penetrates the enclosure box. The efficiency of these control devices drops off rapidly as distance from the pickup area increases. Capture efficiency outside the enclosure is negligible. The efficiency of these local exhaust enclosures can be adversely affected by small changes in air flow in the local area where installed. **As in the case of snorkels, these local exhaust enclosures are only appropriate for use with low-hazard materials and are not an adequate substitute for higher-efficiency control devices that must be used when working with moderate- to high-hazard materials.**