University of Miami

Office of Environmental Health and Safety

Laboratory Safety Manual

Revision Date: Aug-25-2021

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KEY CONTACT INFORMATION

EMERGENCY (Fire/Police/Ambulance)	**911**
University Switchboard (any campus)	305-284-2211 or 1-800-227-0354
Coral Gables	
University of Miami Police Department (UMPD) (https://umpd.miami.edu/)	
EMERGENCY	**911**
UMPD Dispatch	**305-284-6666**
Telecommunication for the Deaf (TTD)	**305-284-3152**
Miller School of Medicine (http://security.med.miami.edu/)	
EMERGENCY	**911**
Public Safety Dispatch	**305-243-6000**
Non-Emergency	**305-243-7233**
Rosenstiel School of Marine and Atmospheric Science (RSMAS)	
(https://www.rsmas.miami.edu/about-us/administration/office-of-emergency-management/index.html)	
EMERGENCY	**911**
Non-Emergency	**305-421-4766 or 305-710-7991**
Office of Environment Health and Safety (www.miami.edu/ehs)	
Main Office	305-243-3400
Biological and Laboratory Safety	305-243-3269
Hazardous Materials	305-243-3268
Fire Safety	305-243-8443
Industrial Hygiene	305-243-8443
Employee Health	305-243-3267
On Call Emergency Contact	305-299-4684
On Call Emergency Beeper	305-750-0525
Radiation Control (http://facilities.med.miami.edu/divisions/radiation-cont)	**305-243-6369**
Division of Veterinary Resources (DVR) (http://uresearch.miami.edu/research-resources/dvr)	**305-243-2310**
Institutional Animal Care and Use Committee (IACUC) (http://uresearch.miami.edu/regulatory-compliance-services/iacuc)	**305-243-2311**
Institutional Biosafety Committee (IBC) (http://uresearch.miami.edu/regulatory-compliance-services/ibc)	**305-243-2311**
Facilities Management	
Coral Gables (https://fo.fop.miami.edu/index.html)	**305-284-4091**
Medical Campus (http://facilities.med.miami.edu/divisions/physical-pl)	**305-243-6375**
RSMAS (http://fo.fop.miami.edu/about/our-team/our-zones-and-shops/rosenstiel/rsmas/index.html)	**305-421-4815**

INTRODUCTION

The University of Miami is committed to ensuring a safe workplace environment for of all employees, students, contractors, and visitors. The Office of Environment Health and Safety (EHS) promotes workplace health and safety through a variety of policies and programs. This Laboratory Safety Manual details the safety policies, procedures, and standards at the University of Miami.

Developed by EHS, this document comprises a set of laboratory health and safety guidelines designed to protect all persons within in a University of Miami laboratory environment. The scope of relevant federal, state, and local regulations is defined as each subject is addressed throughout the document. These standards may change from time to time and where a provision in this manual is in conflict with a standard or could be interpreted to conflict with an applicable standard, the manual should be interpreted so as to comply with all applicable laws and regulations.

Implementation of the guidelines in this manual is dependent on the cooperation of department chairpersons, faculty, laboratory staff, students, Facilities, EHS staff, and members of safety committees. Although the Principal Investigators (PI) bear the ultimate responsibility for safe conditions and procedures in their laboratories, each member of a laboratory group is responsible for complying with the standards put forth in this manual with the common goal of promoting a healthy and safe working environment for all employees and students.

Since activities in the laboratory are so diverse, this manual should not be considered a comprehensive review of all potential hazards. The Laboratory Safety Manual is a living document subject to modifications. If you have any questions, concerns or suggestions regarding the Laboratory Safety Manual contact EHS at 305-243-3269. The current version of the manual is made available at the EHS website, ehs.miami.edu. The manual may be downloaded and/or printed as a reference.

BASIC SAFETY PRINCIPLES

As defined by OSHA, a laboratory is 'a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.' (29 CFR 1910.1450(b))

General Laboratory Safety Procedures

- The Principal Investigator (PI) is responsible for implementing and maintaining safe working practices within the laboratory. Each laboratory worker must assume responsibility for conducting procedures in a safe and proper manner according to the laboratory Standard Operating Procedures (SOP).
- Laboratory personnel must know all the materials (chemical, biological, radioactive, etc.) that are present in the laboratory. Refer to the written laboratory SOP and review the safety data sheets (SDS) for chemical information. Consider the toxicity of materials, the hazards of each step of the procedure, and available safety equipment.
- Access must be restricted to authorized personnel. Laboratory doors are to be kept closed. Relevant warning signs shall be posted as required.
- Safety equipment, such as fire extinguishers, eyewash fountains, emergency showers, spill kits, etc., is located in or near laboratories. Laboratory personnel shall be familiar with the resources and equipment available.
- Appropriate clothing must always be worn while in the lab. This includes shirts, pants, and shoes that provide coverage from the neck to toe. Clothing that exposes skin is prohibited.
- Personal Protective Equipment (PPE) is required for work in the laboratory based on the nature of the research and risk assessment. This includes safety glasses, gloves, and lab coats, but may also include goggles, face shields, aprons, earplugs, and respirators. PPE should be made of adequate materials to ensure compatibility with materials and processes involved in the research.
    - Safety glasses or chemical goggles must be donned before entering any wet bench lab, including cell culture labs. Regular prescription glasses are not adequate substitutes for safety glasses.
    - Gloves should be chosen based on resistance to the chemicals used in the lab. Latex gloves, which have been the most commonly used glove in labs for many years, are not resistant to many of the most common solvents found in laboratories. While there is no single glove material that provides 100% protection from all chemicals, a good all-purpose glove is nitrile. A SDS may be consulted for a definitive answer on appropriate glove material for your research.
    - Lab coats must be donned before handling chemicals, biologicals, or unsealed radiological sources.
- Remove PPE before leaving the work area. Remove contaminated gloves before handling door handles/knobs.
- Hair must be tied back at all times in the laboratory.
- Avoid working alone in the laboratory. If an individual is working alone in the laboratory, procedures shall be included in the SOP to ensure periodic communication between that individual and other laboratory personnel or with Campus Security.
- Preparation, storage and consumption of food and beverages, chewing gum, the application of makeup and lip balm, and handling of contact lenses is prohibited at all times in all laboratory areas.
- All chemicals containers must be labeled as per their contents and stored based on their chemical hazard class. Do NOT store chemicals alphabetically.
- Always work with hazardous chemicals in a properly operating and certified chemical fume hood with the appropriate PPE.
- Know the evacuation procedures for the building. For more information visit the University of

Miami Emergency Preparedness website at https://prepare.miami.edu/index.html.

- Do not use hallways and means of egress as storage areas. Access to exits, means of egress, emergency equipment and controls shall be kept clear of obstructions.
- Follow approved procedures for hazardous, radioactive, and biomedical waste disposal in compliance with the University of Miami policies. Contact EHS for more information or visit the website at https://ehs.miami.edu/.
- Work areas must be kept clean, organized and uncluttered at all times. All items must be properly stowed when not in use or disposed of appropriately when no longer needed.
- Gas cylinders (full or empty) must be secured either by clamping to the bench or chained to the wall at all times.

Self-Imposed Hazards

Self-imposed hazards may result from poor judgement, carelessness and/or lack of familiarity with the surroundings or procedures. Many of these hazards can be avoided with proper planning and the use of common sense. Self-imposed hazards include but are not limited to the following:

- Lifting heavy equipment improperly or without assistance.
- Using a cluttered or disorganized workspace.
- Failing to promptly clean spills.
- Using electrical equipment on a damp or wet surface.
- Using equipment with frayed, damaged or exposed wiring.
- Failing to wear the appropriate PPE (safety goggles, face shields, laboratory coats, etc.) or using engineering controls (fume hoods, biosafety cabinets, etc.) when working with chemical, biological and/or radiological hazards.
- Leaving hot plates or gas valves "ON" when no one is present.
- Obstructing fire exits or means of emergency egress.
- Eating and drinking in the laboratory.
- Preparing and storing food and beverages in laboratory refrigerators, freezers and/or microwaves.

STANDARD OPERATING PROCEDURES (SOP)

The PI has the responsibility to provide laboratory personnel with laboratory SOP when working with any hazardous materials. An SOP is an established set of methods that describes how to perform a procedure. When using chemicals or biological agents, the PI shall prepare a written SOP outlining the safety precautions needed when handling a particular chemical or biological agent.

The SOP should address, but is not be limited to, the following practices:

- Identify all chemicals, biological agents and equipment that will be used in the process
- Engineering controls
- Administrative controls
- PPE
- Equipment checks
- Potentially hazardous procedures
- Access restrictions
- Decontamination procedures
- Waste disposal procedures
- Medical surveillance or monitoring of personnel as required
- Establishment of an emergency plan
- Regulatory compliance as necessary

Researchers using extremely hazardous chemicals are required to submit an SOP to EHS for review and approval before conducting activities. All labs using biological agents must complete a Biological Hygiene Plan with the submission of their BioRAFT Biological Registration.

SAFETY TRAINING

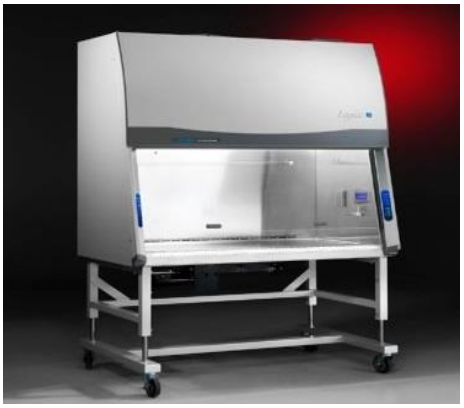
Personnel training is mandatory according to regulations and policies such as the OSHA Laboratory Safety Standard (29CFR 1910.1450). The PI is primarily responsible for training employees on the steps of the procedures associated with a research area. Before an employee is assigned to work in a laboratory, the PI must also provide relevant safety training for procedures conducted in that area.

The following includes a list of areas that should be covered in the safety training of personnel working in a laboratory:

- Emergency information including medical contingencies (general first aid, needle stick injuries, serious injury, etc.), evacuation and fire escape plans, and spill response procedures.
- Fire safety devices including pull stations, fire extinguishers, etc. The employee must understand the proper circumstances in which to use each item as well as how to use these devices correctly.
- Emergency devices including emergency showers and eyewash fountains. The employee must be familiar with the location and appropriate use of these items. ***Note: Eyewash bottles are not acceptable alternatives to eyewash fountains.***
- PPE including, but not limited to, safety clothing (lab coats, chemical aprons, surgical scrubs, etc.), gloves, safety glasses, face shields, and respirators. The selection and use of PPE is dependent upon proper hazard identification by the PI. The employee must be familiar with the hazards present in the work area and with the use of the appropriate PPE. ***Note: The use of respirators in the laboratory is not usually necessary if the proper engineering controls are in place. However, under any circumstances, all respirator usage must be authorized by EHS and conducted in accordance with the University's Respiratory Protection Policy.***

- Employees must be trained on the operation of chemical fume hoods, biological safety cabinets, and laminar flow hoods. These devices should not be used for storage or shelf space. These devices are required to be inspected or certified annually. The PI has the responsibility to have the biosafety cabinets and laminar flow hoods certified by an outside contractor annually or whenever physically moved.

Fume Hood



Biological Safety Cabinet (BSC)

- SDS contain safety information on the chemicals. The employee must be informed of the importance of this information and where to obtain them.
- The employee should be familiar with safety information on chemical labels and with the variety of hazard warning signs (biohazard, laser, NFPA diamond, etc.).
- Employees working in Designated Areas in laboratories must be familiar with the SOP for those areas.
- The employee should be familiar with the safety hazards associated with different chemical hazard class (flammables, corrosives, combustibles, etc.). Proper storage of chemicals by chemical hazard class should also be explained by the PI.
- Chemical and biomedical waste disposal shall be done according to the University's policies and follow federal, state and local regulations. The employee must know the policies and

procedures for labeling, storing, and disposing of the wastes in their laboratory.
- All University of Miami employees must be informed about the hazards associated with their workplace. The safety resources, plans, the SDS inventory and more information can be found at the EHS website (https://ehs.miami.edu/).
- The employee must be familiar with the policies and procedures for bloodborne pathogens and tuberculosis.

Federal Law (OSHA's Hazard Communication Standard) mandates that the above training information be reviewed each time the employee is reassigned to a new task or if a new hazard is introduced in the workplace.

Training Courses

EHS offers the following training classes. Training is available through several platforms, including ULearn, Blackboard or contacting EHS (through the website, email, or office phone at (305) 243-3400.

Laboratory Safety / Hazardous Waste Disposal / Satellite Accumulation Area Training
This training presents best practices for general laboratory safety and outlines the risk assessment process when handling hazardous chemicals, chemical waste and its disposal, laboratory ventilation, chemical spill kits and personal protective equipment. It educates the audience in the compliance process with all applicable regulations, standards, and guidelines. All faculty, students and staff that work in an academic or research laboratory must take this training.

General Biosafety Training
This training outlines the risk assessment process for biological research. It covers risk mitigation for biological labs and how these specifically apply to research labs at UM, including engineering controls, work practice controls, personal protective equipment, and administrative controls. All laboratory personnel working with biological materials must complete this training.

OSHA Bloodborne Pathogens, Tuberculosis, Latex Allergy, and Biomedical Waste Training
This session provides information on the transmission of bloodborne pathogens and how to protect against infection and procedures for post-exposure medical evaluation. This training is mandatory for all persons having potential occupational exposure to human blood or most human body fluids, unfixed human tissue, or laboratory or animal material contaminated with HIV or HBV.

Shipping of Dangerous Goods Training
This training familiarizes the user with the regulations and requirements laid out by the IATA Dangerous Goods Regulations and the US Department of Transportation for shipping hazardous materials. This training is required for all employees involved in the shipment of hazardous materials This may include chemicals, paints, batteries, biologicals, and more.

Shipping of Biological Materials Training
This training covers all points for shipping biological materials and commonly used preservatives in biological shipments. It includes specific information for packing, labeling, and shipping a given biological material. This training is required in addition to the Shipping of Dangerous Goods training and is required for anyone shipping biological materials.

Fire Safety Training
This session provides a basic understanding of general fire hazards, the safety precautions to take, evacuation procedures, and how to use a fire extinguisher. Practical fire extinguisher training is also available upon request. Contact the EHS Fire Safety Manager through the website contacts page, https://ehs.miami.edu/contact/index.html.

Respiratory Protection Training

This training covers information needed for respirator users encountering respiratory hazards (harmful dusts, fibers, biological hazards, fumes, mists, gases, smokes, sprays, or vapors) that can cause occupational diseases (specially Aerosol Transmissible Diseases (ATDs) like tuberculosis, measles, COVID-19). The priority is to minimize routes of respiratory exposure through engineering control measures (e.g., enclosure or confinement of the operation, exhaust ventilation) or administrative control measures (e.g., substitution of less toxic materials). When effective engineering and/or administrative controls are not feasible or while they are being instituted, appropriate respirators shall be provided and used pursuant with this program.

Basic Laser Safety Training

This session training covers the topics required by ANSI Z136.1. The required topics are:

- Fundamentals of laser operation
- Bioeffects of laser radiation on the eye and skin
- Significance of specular and diffuse reflections
- Non-beam hazards of lasers
- Laser and laser systems classifications
- Control measures
- Overall responsibilities of management and employee
- Medica examination practices (if applicable)

This training is mandatory for all laser operators, observers, and anyone associated with Class 3B and 4 lasers. It is recommended for operators, observers, and anyone associated with Class 1, 1M, 2, 2M, and 3R lasers.

CHEMICALS

Chemical safety encompasses understanding chemical hazards, minimizing exposure to chemicals, and proper labeling, storage and segregation, transport, and disposal of chemicals in the laboratory and other facilities. The PI is responsible for maintaining an accurate inventory of the chemicals in the laboratories. The inventory must be regularly updated and submitted to EHS (usually submitted at the EHS Annual Laboratory Safety inspection). The SDS, previously known as the Material Safety Data Sheet (MSDS) provides information on hazards of a chemical. The SDS for all chemicals in the laboratory must be made available to all laboratory personnel either by printed hard copy kept in the laboratory or online via Workday.

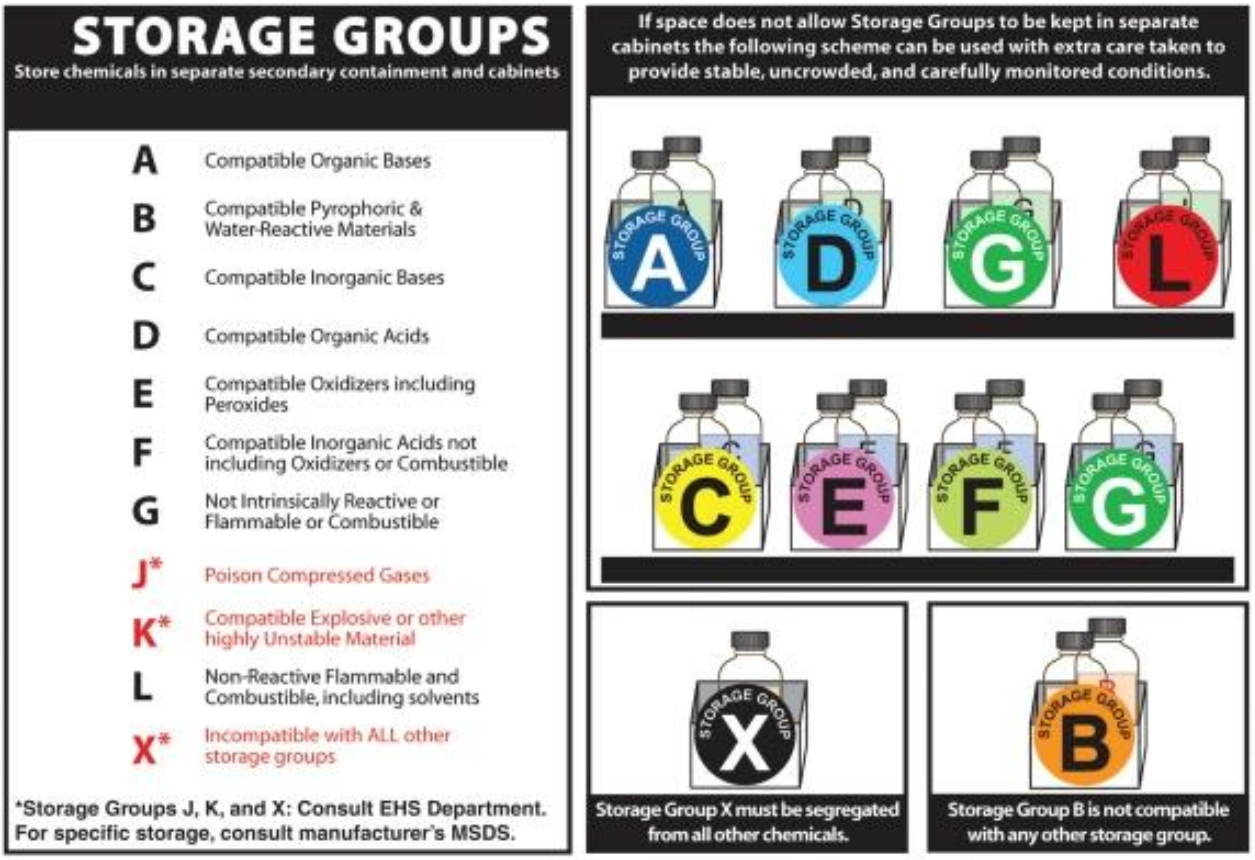
Storage

Proper chemical storage is a fundamental aspect of laboratory safety. The number and amounts of chemicals that need to be stored should be kept to a minimum. Chemicals should be stored based on their compatibility and not in alphabetical order. Acids, flammable liquids, halogenated materials, oxidizers, and highly reactive chemicals should all be separated and stored properly to avoid unwanted chemical reactions. Information on chemical storage compatibility can be found in Table 1.

The following are chemical storage guidelines that laboratories must adhere to:

- All chemicals MUST be labelled.
- Incompatibles chemicals must not be stored together (see Table 1).
- Amounts of chemicals stored in the laboratory must be kept to a minimum.
- Containers must be closed at all times when not in use.

Table 1. Compatible Storage Group Classification System.



Handling Procedures for Selected Groups of Chemicals

Additional safety procedures should be used when handling the following commonly used groups of chemicals:

Peroxidizable compounds (ethers) are a group of chemicals, which become shock sensitive when they form organic peroxides (see Table 2). This reaction is catalyzed by changes in sunlight, temperature, and pressure. Store these compounds in an airtight container, preferably 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. Ethers should be purchased in amounts and container sizes appropriate for the intended use and dated upon receipt. Once opened, a container should be used within six months. Unopened containers must be disposed of through EHS as chemical waste.

Table 2. Selected Peroxidizable Compounds[1]

CLASS I[2]

Acrylic Acid	**Tetrafluoroethylene**
Acrylonitrile	**Vinyl Acetate**
Butadiene	**Vinyl Chloride**
Chlorobutadiene (Chloroprene)	**Vinyl Acetylene**
Chlorotrifluoroethylene	**Vinyl Pyridine**
Methyl Methacrylate	**Vinylidene Chloride**

CLASS II[3]

Acetal	**Dioxane (p-Dioxane)**
Cumene	**Ethylene Glycol Dimethyl Ether (Glyme)**
Cyclohexene	**Furan**
Cyclooctene	**Methyl Acetylene**
Cyclopentene	**Methyl Cyclopentane**
Diacetylene	**Methyl-i-butyl Ketone**
Diethylene Glycol Dimethyl	**Tetrahydronaphthalene**
Diethyl Ether	**Vinyl Ethers**

CLASS III[4]

Organic	Inorganic
Divinyl Ether	**Potassium Metal**
Divinyl Acetylene	**Potassium Amide**
Isopropyl Ether	**Sodium Amide (Sodamide)**

[1]The information in this table is courtesy of the Emergency Technical Services Corporation of Schaumburg, Illinois.

[2]Unsaturated materials, especially those of low molecular weight, may polymerize violently and hazardously due to peroxide initiation.

[3]These chemicals are a peroxide hazard upon concentration (distillation/evaporation). A test for peroxide should be performed if concentration is intended or suspected.

[4]Peroxides derived from the listed compounds may explode without being concentrated.

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 pressure and temperature. These substances should be stored separately from oxidizers and corrosive materials and in a flammable storage cabinet if available in the work area. 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 3 for storage limitations imposed by OSHA and NFPA.

Table 3 **Flammable and Combustible Liquid Storage Limits for Laboratories[1]**

Laboratory Unit Class	Flammable or Combustible Liquid Class	*Excluding* Quantities in Storage Cabinets[2] or Safety Cans	*Including* Quantities in Storage Cabinets[2] 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, and 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 **EHS**.
[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.

Corrosive chemicals

These chemicals may 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.

Oxidizing agents

These 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 4) should be stored and used in glass or other inert containers. Cork and rubber stoppers should not be used with these substances.

Table 4. Examples of Oxidizing Agents[1]

Gases:	**Fluorine, Chlorine, Ozone, Nitrous Oxide, Steam, Oxygen**
Liquids:	**Hydrogen Peroxide, Nitric Acid, Perchloric Acid, Bromine, Sulfuric Acid, Water**
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.

Highly reactive chemicals

These chemicals are inherently unstable and can react in an uncontrolled manner to liberate 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.

The following additional procedures are recommended for handling reactive chemicals:

- Secure reaction equipment properly.
- Use impact protection (shields and guards) in addition to chemical splash protection (eye protection, gloves, laboratory coat, etc.).
- Handle shock-sensitive chemicals gently to avoid friction, grinding, and impact.

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 EHS for additional information about the storage of a specific chemical.

Extremely Hazardous Chemicals

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 (see Table 5 for additional examples). Substances that have high chronic toxicity may cause adverse health effects after repeated exposure over a period of time. These may include carcinogens, reproductive toxins, mutagens, and sensitizers.

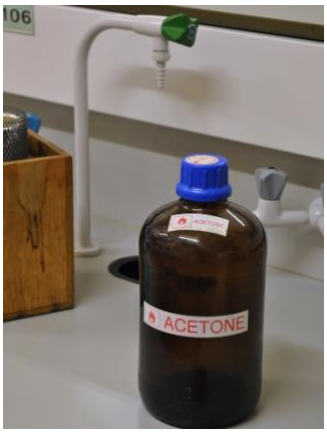
The PI bears the responsibility for the safe use of extremely hazardous chemicals in the laboratory. Researchers must create a Designated Area (see definition in the glossary) in the laboratory which is physically separated and visually labeled with appropriate warnings. Access to the Designated Area must be strictly controlled. Engineering controls (such as fume hoods and biosafety cabinets) must also be located in this Area. PIs using extremely hazardous chemicals will be responsible for submitting an SOP to EHS for review and approval before this Designated Area can become active. The SOP must outline the methods that will be used for the proper handling of these chemicals in the Designated Area and access restrictions to this Area.

Table 5. Examples of Extremely Hazardous Chemicals[1]

Acrolein	Nickel carbonyl
Arsine	Nitrogen
Chlorine	Dioxide
Diazomethane	Osmium
Diborane	Tetroxide
Hydrogen cyanide	Ozone
Methyl fluorosulfonate	Phosgene
Sodium azide	

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

Labeling



All containers (including beakers, vials, flasks, etc.) must be labeled with the chemical constituent(s) and other relevant information. This includes dilution 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, the new container must have the name of the chemical and other relevant information. Damaged or faded labels must be replaced before becoming illegible. Additional information on labeling requirements can be found in the University's Right to Know and Hazard Communication Policy.

Spills

Each laboratory must maintain a Chemical Spill Kit appropriate for the varieties and quantities of chemicals in that laboratory. This kit must be labeled and accessible. The following are the recommended components of a basic chemical spill kit:

- Polypropylene or high-density polyethylene bucket with top – (5 gallon or larger)
    - Should be well labelled and easily accessible to all members of the laboratory. The purpose of this item is to act as a receptacle for chemical resistant bag liners during a spill clean-up and as a storage container for the spill kit components.
- Personal protective equipment (PPE) – (safety eyewear, gloves, etc.)
    - Safety eyewear: Spare safety glasses and/or goggles should be included in the spill kit.
    - Gloves: No gloves are chemical proof, however, some are resistant to more chemicals than others. Nitrile, neoprene, and butyl rubber gloves are some examples. Latex gloves are not resistant to most laboratory chemicals and should not be in the spill kit.
    - Aprons / Shoe covers / Lab coats / other PPE: Refer to the SDS to ensure that all of the requirements for PPE have been fulfilled
- Tools – (chemical resistant, nonsparking (plastic) dustpan or scoop and brush, etc.)
    - Clean-up tools such as dustpan, scoop and brush, etc. should be chemical resistant and nonsparking (plastic).
- Inert absorbents – (vermiculite, sand, clay, absorbent socks or pillows, etc.)
- Neutralizing and treatment materials – (type and quantity are dependent on the laboratory's chemicals)
    - Acids Spills: Sodium bicarbonate, sodium carbonate, and commercial kits designed for acid spills are sufficient for neutralizing many acids. Some of the commercial kits have color indicators to show when a spill has been neutralized.
    - Alkali Spills: Citric acid, sodium bisulfate, and commercial kits designed for alkali or caustic spills are sufficient for neutralizing many bases. Some of the commercial kits have color indicators to show when a spill has been neutralized.
    - Solvent Spills: Commercial solvent treatment materials may be used to reduce vaporization and raise the flash points of some solvents.
- Chemical resistant bags
    - All spill residue and spill clean-up material needs to be placed in a high density polyethylene or polypropylene bag.

The above information are general recommendations for the core components of a spill kit. The quantity and potential hazard of chemicals must be considered and SDSs must be consulted before a spill kit is completely stocked.

The following are procedures to address a chemical spill that you can contain:

1. Neutralize acids and bases whenever possible. Use baking soda (sodium bicarbonate) or some other appropriate neutralizer.

2. Control and absorb liquid releases. Use absorbent materials (vermiculite, kitty litter, oil dry, etc.) to dike the contaminated areas and prevent the spread of a liquid release.
3. Store waste absorbent materials properly. After cleaning the release area, place waste products in a properly labeled container and contact EHS for disposal.
4. Decontaminate the area and affected equipment. Increase ventilation to the area by using fans or opening windows if available. Contact EHS for an indoor air quality assessment if necessary.
5. 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 "broken glass," where appropriate.

Always restock the spill control kit after completing clean-up to make sure the kit is ready for the next occurrence. It is recommended to regularly check the spill kit(s) to ensure all supplies are present.

For a chemical spill that you cannot contain with the spill kit the following procedures must be taken:

1. Evacuate all persons in the laboratory and surrounding areas as appropriate.
2. Isolate the area (close door to lab).
3. Contact EHS and Security immediately.

Do not enter the laboratory until permitted to by appropriate Emergency Services Agency.

FUME HOODS

The fume hood is one of the primary safety engineering controls for handling chemicals and some radioactive materials in the laboratory.

EHS will

- be responsible for periodic inspection and certification of the fume hoods.
- monitor the preventive maintenance program for the fume hoods .
- 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 operator. Before using a fume hood, the operator must identify what types of chemicals will be used in this device. There are two basic categories of fume hoods: General Purpose and Special Purpose.

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:

- 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.
- 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.
- Auxiliary Air Hood, designed to introduce outside air into the hood and limit the amount of room air that is exhausted.
- Variable Air Volume (VAV) Hood, designed to regulate the hood exhaust and keep the air velocity at a predetermined level.

Special Purpose Hoods

Certain research activities involve the use of substances which 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.

Perchloric Acid Fume Hoods

Procedures with Perchloric acid must never be done in a regular fume hood. Special Perchloric acid hoods must be used. These hoods are generally made of non-corrosive materials (stainless steel), and 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 should wash down the hood and ductwork with water.

Radioisotope Fume Hoods

Any research activity involving chemical radiolabeling must be done in a fume hood appropriate for such activities and must meet the requirements set forth by the University of Miami's Radiation Control Center (RCC). These requirements include, but are not limited to, the following:

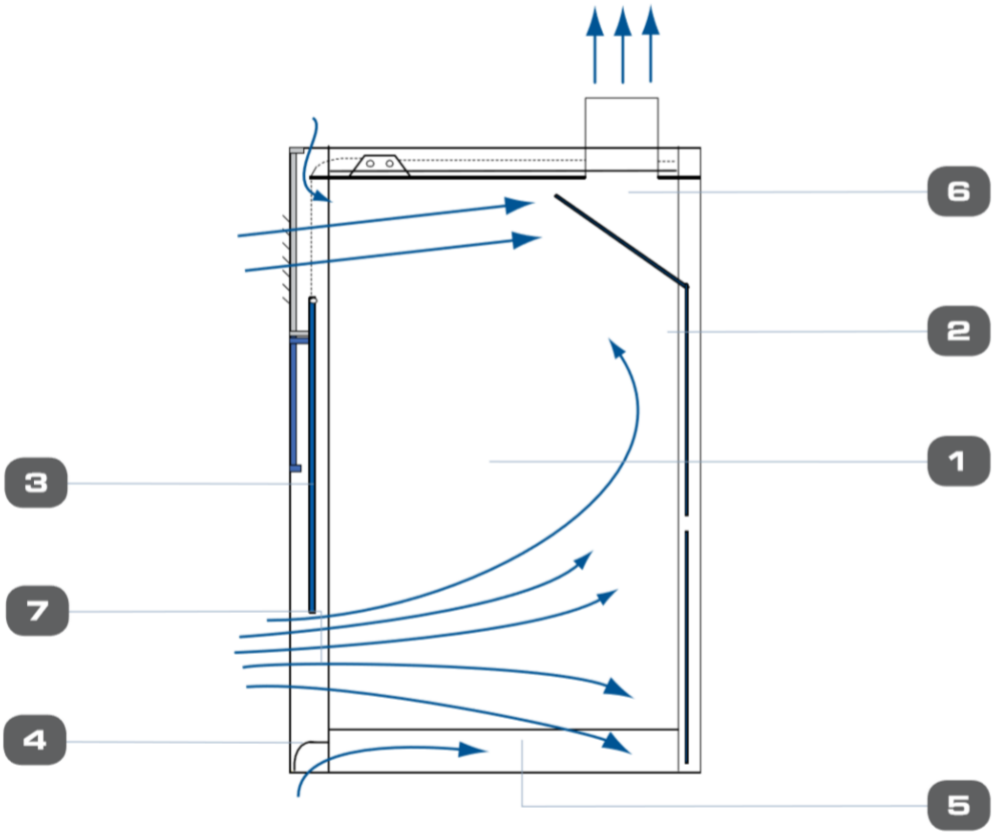
- Certification by the RCC before radiolabeling procedures begin and at routine intervals thereafter, not to exceed one year.
- Establishment of a minimum flow rate of 100 linear feet per minute (LFM) across the sash

opening of the fume hood with a minimum face area (the region between the sash level and the bottom airfoil) of four square feet.

- Operation twenty-four hour per day, 365 days per year for those hoods used with tritium or radioiodine.
- Maintenance of a Use Log for each radioisotope fume hood to assure that the established release limits are not exceeded.

Radioisotope fume hoods are required for chemical radiolabeling and other procedures where there is a potential release of volatile radioisotopes. For more information concerning the proper use and containment of radioisotopes, contact the RCC.

Components of a Fume Hood



Taken from "A Guide to Laboratory Fume Hoods" (http://www.escoglobal.com/products/download/1334055898.pdf).

1. Hood Body – The visible part of the fume hood that serves to contain hazardous gases and vapors.
2. Baffles – Moveable partitions that keep the airflow uniform to eliminate dead spots and optimize efficiency.
3. Sash – The sash is the "door" to the hood. By using the sash to adjust the front opening, airflow across the hood can be adjusted to the point where capture of contaminants is maximized. Each hood has its optimum sash configuration. The sash should be held in this position when working in the hood and closed completely when the hood is not in use.
4. Airfoil – Located along the bottom and side edges the airfoil streamlines airflow into the hood, preventing the creation of turbulent eddies that can carry vapors out of the hood. The space below the bottom airfoil provides source of room air for the hood to exhaust when the sash is fully closed. Removing the airfoil can cause turbulence and loss of containment.
5. Work surface – Generally a laboratory bench top, or the floor in the case of a floor-mounted

hood, this is the area where the work is conducted.

6. Exhaust plenum – The exhaust plenum helps distribute airflow evenly across the hood face. Materials such as paper towels drawn into the plenum can create turbulence in this part of the hood, resulting in areas of poor airflow and uneven performance.
7. Face – The imaginary plane between the bottom of the sash and the work surface. Hood face velocity is measured across this plane.

General Safety Practices with Fume Hoods

- Fume hoods are not designed for storage. Items (equipment, chemicals, etc.) within the fume hood should be minimized. Remove all items not required for procedures in progress.
- A fume hood should be physically inspected before use to make sure that it is functioning properly. A convenient test method is a tissue paper streamer attached to the bottom of the sash.
- All work should be conducted no closer than six inches behind the plane of the face (sash opening) of a fume hood.
- Any items within a hood must not obstruct the baffle openings or impede air flow at the face of the fume hood.
- Fume hoods should be operated with lowered sashes whenever possible.
- Baffles must only be adjusted by Physical Plant or other authorized personnel. Laboratory personnel should not manipulate fume hood baffles.

RADIATION SAFETY

The use of radioactive materials and ionizing radiation producing devices at the University of Miami is regulated by the State of Florida under an agreement with the U. S. Nuclear Regulatory Commission. The responsible University agency for such activities is the University of Miami Radiation Control Center (RCC) and the document which details the rules and regulations which have been adopted to ensure both the safety and regulatory compliance of radiation use is the Radiation Control Manual.

All individuals who intend to use radiation in University of Miami facilities must contact the RCC, prior to initiating such work, for further information concerning required training and authorizations. It should be noted that all radioactive material is regulated at the University of Miami and no quantity, no matter how small, is considered exempt from these regulations, including Generally Licensed materials. For additional information concerning the use of radioactive materials and ionizing radiation producing devices, please contact the RC.

Laboratory Rules

The following University of Miami Radioisotope Use Area Laboratory Regulations must be applied in all areas of radioisotope use:

- Eating, drinking, smoking and the application of cosmetics in the laboratory are prohibited.
- Never pipette by mouth.
- Prescribed personnel monitors must be worn.
- Gloves and laboratory coats are required when using radionuclides.
- Work with radionuclides must be performed in an approved hood or glove box, unless the safety of working on an open bench can be demonstrated.
- All areas of radionuclide use must be covered with absorbent paper.
- Thoroughly wash hands after manipulating radionuclides, before eating, drinking or smoking, and on completion of work. Survey hands for contamination, as appropriate, after washing.
- All containers of radionuclides must be appropriately marked with isotopes, activity and date.
- Maintain records of receipt, use, contamination surveys, transfers and disposal of radioactive materials.
- Radioactive materials must be disposed in accordance with a laboratory's specific approved protocols.
- Perform surveys of radionuclide use areas as provided in the Radiation Control Manual and in specific approved protocols.
- Report accidental inhalation, ingestion, injury or spills to the laboratory supervisor and the RCC.

In case of emergency follow the posted Emergency Procedures.

All areas of radioisotope use must be properly posted to include the phone number of a responsible person to be contacted in case of an emergency.

All radioisotope use must be specifically approved by the appropriate Radiation Safety Sub-Committee and be in compliance with the University of Miami Radiation Protection Plan and with Florida Administrative Code Chapter 64E-5.

Failure to comply with these regulations in their entirety may lead to suspension or revocation of authorization to use or possess radioisotopes in University of Miami facilities. Emergency Procedures

The following Radioisotope Use Emergency Procedures must be followed in all incidents involving radioactive materials.

Traumatic Injuries

If the incident involves traumatic injury to any individual, first aid should be given without regard to any possible radiation contamination. Emergency personnel should, however, be notified immediately of such potential so that appropriate precautions can be taken in the course of treatment to minimize the impact of contamination. Minor Spills Less than 10 µCi in a volume less than 10 ml or at a concentration less than 0.00045 µCi/ml and not involving personnel contamination or injury.

- Notify: Notify persons in the area that a spill has occurred.
- Prevent the Spread: Cover the spill with absorbent paper.
- Clean Up: Use disposable gloves. Use remote handling tongs when possible, if an external exposure hazard is involved. Decontamination should proceed from the outer edges of the spill in toward the center. Carefully fold decontamination materials with absorbent paper and pad and insert into a plastic bag for disposal with radioactive waste.
- Survey: Survey the area for residual contamination as appropriate for the isotopes involved and if contamination in excess of the established decontamination limit (1000 dpm per 100 cm2) is found, continue to decontaminate the area and resurvey.
- Report: Report the incident in writing to the Radiation Control Center along with the results of all surveys.

Major Spills

- Define as more than 10 µCi or a volume of more than 10 ml at a concentration of greater than 0.00045 µCi/ml or any incident involving personnel contamination or injury or any spill occurring outside of an approved area of use.
- Clear the Area: Notify all personnel not involved in the spill to vacate the area.
- Treat Injuries: Treat any injured personnel or call for emergency personnel as required.
- Prevent the Spread: Cover the spill with absorbent pads, but do not attempt to clean it up. Limit the movements of all potentially contaminated individuals to prevent the spread.
- Shield the Source: If an external radiation hazard is involved an attempt should be made to shield the spill if it can be done without further contamination or significant radiation exposure to the individual placing the shield.
- Control Access: Prevent access by any personnel to the area of the spill.
- Call for Help: Notify the RCC immediately and await specific decontamination instructions.
- Personnel Decontamination: Contaminated clothing should be removed and held for evaluation by RCC personnel. If the spill is on the skin, flush thoroughly and then wash with mild soap and lukewarm water.
- Facility Decontamination: Decontamination will be performed by laboratory personnel under the direction of the RCC. Appropriate protective clothing and personnel monitors will be issued by the RCC as needed.
- Surveys: Surveys to determine the effectiveness of the decontamination procedures will be performed by laboratory personnel with RCC personnel performing confirmatory surveys. Under no circumstances will the area be cleared for use until such surveys indicate that the contamination level is below 1000 dpm per 100 cm2.
- Incidents Involving Volatile Radioisotopes Any incident involving the potential release of volatile radioisotopes outside of an approved fume hood.
- Clear the Room: Notify all personnel that a potential release has occurred and after closing any windows, and if possible shutting off air conditioners, vacate the room but not the area.
- Secure the Room: Close and lock all doors to the room and seal edges with tape.
- Isolate the Room: Notify physical plant so that any common air handling equipment serving the room can be shut off.
- Call for Help: Notify the RCC and await instructions. Under no circumstances is anyone to re-enter the room except under the direct supervision of the Radiation Safety Officer or his designee.
- Decontamination and Surveys: Decontamination and surveys should proceed in the manner

indicated previously for major spills.

PLEASE NOTE THAT DECONTAMINATION IS THE RESPONSIBILITY OF THE INDIVIDUAL LABORATORY INVOLVED IN THE INCIDENT AND WILL BE PERFORMED BY PERSONNEL FROM THAT LABORATORY IN ALL CASES. IN THE CASE OF MAJOR SPILLS OR INCIDENTS INVOLVING VOLATILE RADIOISOTOPES, RCC PERSONNEL MAY SUPPLY EQUIPMENT AND DIRECTIONS AND WILL PERFORM CONFIRMATORY SURVEYS. THESE DO NOT REPLACE THE SURVEYS TO BE PERFORMED BY THE PERSONNEL PERFORMING THE DECONTAMINATION.

Posting of Signs and Documents

All areas of radioisotope use at the University of Miami must be posted as indicated below with approved signs and documents, available from the RCC:

- The entrance to all areas of radioisotope use or storage shall be posted with an approved sign.
- All storage locations of radioactive materials, such as cabinets, drawers, freezers or refrigerators shall be posted with an approved sign.
- All areas of radioisotope use shall have prominently posted a University of Miami Radioisotope Use Area Laboratory Regulations Poster.
- All areas of radioisotope use shall have prominently posted a copy of the Emergency Procedures.
- All areas of radioisotope use shall have prominently posted a copy of State of Florida DH Form 1081 "Notice to Employees" indicating the availability of required documents at the RCC.
- All radioisotope use areas shall have posted on the entry door, so that it is visible when the laboratory is closed, the name and phone number of the responsible individual from the laboratory to be contacted in case of an emergency. This is in addition to the contact for the RCC which must also be posted. This must be an individual with detailed knowledge of the day to day operations of the laboratory who is aware of the location and condition of all radioisotopes within the laboratory.

Please note that radioactive materials signs should only be posted on those areas for which they are appropriate. They are not to be used solely to discourage entry by unauthorized individuals into areas where radioisotopes are not used or stored.

Any area which is posted with radioactive materials signs is subject to all the provisions of the Radiation Control Manual and State of Florida regulations, and access and oversight by the Radiation Safety Officer or RSO proxy, even if no radioisotope use or storage is being undertaken in the area at the time.

Radioactive Waste Disposal

All disposal of radioactive materials at the University of Miami must be in accordance with State of Florida regulations and protocols specifically approved by the appropriate Radiation Safety Sub-Committee. The acceptable methods for the removal of radioactive waste include:

1) sink disposal of limited quantities of radioisotopes in aqueous solutions and
2) transfer to the RCC.

Additionally, individual laboratories must not hold waste for decay, nor take credit for decay which occurs during the time the material is in the laboratory when determining inventory levels. The use of all radioactive materials or radiation producing devices in the laboratory must follow the RCC requirements and regulations. For more information, contact the RCC.

Radiation Control Center
305-243-6360
1600 NW 10th Avenue, Suite 1081A RMSB
Miami, Florida 33136
http://facilities.med.miami.edu/divisions/radiation-cont

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. In addition, compressed gases, when handled incorrectly, can be very dangerous with a high potential for explosion. Although each Department of Transport (DOT) approved gas cylinder is designed, constructed, and tested to safely contain its contents, additional procedures should be followed in handling and storing compressed gas cylinders:

- Cylinders must be clearly labeled with their contents.
- Regulators must be compatible with the cylinder contents and valve.
- Cylinders must be properly secured at all times.
- Cylinders must be stored in a cool, well-ventilated area away from sources of ignition, electricity, and heat.
- Empty or unused gas cylinders must always be capped.
- Cylinder carts must be used to transport capped cylinders.
- Cylinders containing flammable gases must not be stored near oxidizers.
- Cylinders must not be stored near corrosives.
- Cylinders must be stored away from doors and exits. The Receiving Department of each campus will handle the delivery and collection of gas cylinders.
- All cylinders (new, used, or empty) must be secured at all times.
- Chains, belts, or clamps should be used to secure cylinders to the walls or benches in the laboratory.
- Do not store gas cylinders in the hallway.
- 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 is responsible for the additional costs of disposal.
- 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 EHS for additional information.

CRYOGENS

Cryogenic Liquids (cryogen) is defined as having a boiling point below -150°C. Carbon dioxide and nitrous oxide have a higher boiling but are sometimes included in this category. The OSHA Hazard Communication Standards (29 CFR 1910.1200) is considered a hazardous material.

Extreme Cold

Skin contact with cryogenic liquids, vapors and gases can cause burns.

Personal Protective Equipment (PPE) for Cryogens

The following is a list of PPE that must be used when working with cryogens:

- Face Shield
- Safety Goggles (covers the entire eye area – no gaps)
- Lab Coat (covering front of body and sleeves covering entire arm
- Cryogenic use specific gloves
- Long pants: Legs must be completely covered, no holes or rips
- Closed toed shoes: Must be made of fluid resistant material and cover the entire foot.

First Aid Procedures for Cryogenic Exposures

Skin Contact

- Wash contaminated area with water and soap
- Remove contaminated clothing (ensure appropriate PPE is worn)
- Go to Emergency Room if burn and/or frostbite signs or symptoms occur

Eye Contact

- Flush eyes immediately with water for at least 15 minutes
- Seek medical attention if irritation continues

Inhalation

- Leave the area to an area with fresh air
- If breathing is difficult or absent call 911 immediately
- Seek medical help if any symptoms occur, some symptoms are delayed

Surplus cryogenic liquids and empty tanks must be return to supplier as per supplier's instructions.

COLD ROOM

A cold room is considered a laboratory and is subject to the OSHA Laboratory Standard (29 CFR §1910.1450). Most cold rooms are shared by multiple Principal Investigators (PI). Therefore, all individuals using the cold room are responsible for maintaining a safe and clean area.
All items, including samples and equipment, must be properly labeled with the contents, PI's name, building and room number, and date of storage.

Signage
An Emergency contact sign must be placed on the outside of the cold room with ALL of the PIs using the cold room and two more emergency contacts for each PI. A Biological Agents Level 2 (BSL2) sign must be placed on the cold room door if BSL2 are stored or used in the cold room. Contact EHS for Emergency Contact and BSL2 signs.

Health and Safety issues that can occur in a cold room when proper laboratory practices are not carried out are:

- Chemical Hazards
- Mold Growth
- Structural Damage

Chemical Hazards
The storage of chemicals in the cold room must comply with the OSHA Laboratory Standard (29 CFR §1910.1450), EPA regulations, and University policies and procedures. Most cold room's air circulation is not exhausted therefore careful attention needs to be made with the storage of toxic chemicals and flammable solvents. Toxic chemicals and solvents in must not be stored the cold room.

DO NOT store hazardous chemicals, including dry ice, in the cold room.

Mold Growth
Mold can easily occur in a cold room due to the dampness and condensation of the cold room. Store paper products in an airtight plastic container to prevent mold growth. Use closed metal or plastic shelving to prevent mold growth.

Structural Damage
Excess moisture or spilled chemicals can cause structural damage such as rust and corrosion. This damage can compromise the integrity of the shelving, equipment, and structure of the fume hood.

To prevent these issues from occurring routine checks should be carried out as followed as a minimum.

Periodically carry out an inventory of all your items in the cold room and remove any items not in use, have expired, or have mold present.

After every use

- Replace any missing or illegible labels.
- Clean up any spills.
- Close the cold room door firmly.
- Report any leaks to Facilities.
- Avoid working alone.

BIOLOGICAL SAFETY

Biological safety is a set of principles designed to allow laboratory personnel to work with infectious and potentially infectious biological agents safely in order to avoid exposure to themselves and community at large. The principal mechanisms required to handle biological agents safely are based on a risk assessment process. This risk assessment process requires a review on potential exposure points in an experiment and the perceived

Safety Equipment (Primary Barriers)

Equipment designed specifically to minimize exposure to infectious or potentially infectious material or agents is referred to as *primary barriers*. Primary barriers include engineering controls such as biosafety cabinets (BSCs) and safety centrifuge cups. Both are designed to prevent aerosolized infectious agents from being released when handled.

> ***Aerosolized particles (airborne particles)***
> Technically, an **aerosol** is a colloid suspension of fine solid particles or liquid droplets in a gas. The word aerosol derives from the fact that matter "floating" in air is a suspension (a mixture in which solid or liquid or combined solid–liquid particles are suspended in a fluid) colloidal particles (≤ 5 μm) in a gas. Droplets (>5 μm)

Personal Protective Equipment (PPE)

Personal protective equipment includes items such as gloves, lab coats, gowns, shoe covers, face shields, safety glasses, goggles, respirators. Used in combination with engineering controls such as biosafety cabinets, personal protective equipment serves as a primary barrier against infectious and potentially infectious agents. The PPE worn must be suited for the activity and agent(s) being handled as well as user specific. Splashes or mini splashes are of concern when working with biological agents, in particular blood borne pathogens. PPE such as lab coats, gowns, safe shields, and safety glasses serve as a protective barrier for lab personnel directly in contact with the agent and from exposing the community at large to an infectious agent via fomites.

Laboratory Design (Secondary Barriers)

The design and construction of the laboratory or facility is referred to as *secondary barriers*. The design is intended to provide a barrier of protection for individuals in the lab and those outside of the laboratory area from exposure to an infectious agent accidently released from the laboratory.

The laboratory design or recommended secondary barriers will be contingent on the agent(s) and mode of transmission. For example, agents whose transmission requires direct contact or inadvertent contact exposure through contaminated work environments may require secondary barriers such as a separate laboratory work area from public access, availability of an autoclave, and hand washing facilities. For agents whose route of exposure involve aerosols (such as *tuberculosis*) multiple secondary barriers may be necessary to prevent the agent from escaping to the outside environment and exposing non-laboratory related personnel and surrounding community as well as personnel working directly with the agent. Additional secondary barriers may include a specialized ventilation system, controlled access zones, and airlocks at laboratory entrances.

Good Laboratory Practices

While important, primary and secondary barriers are ineffective if good laboratory practices are not followed by individuals working with infectious or potentially infectious agents. Strict adherence to standard microbiological practices and techniques is a fundamental element to maintaining containment of infectious material.

Listed below are examples of good laboratory practices all lab personnel working with an infectious or potentially infectious agent should follow:

- Understand the hazards associated with the agent and follow required practices and procedures related to the agent.
- Work surfaces must be decontaminated before and after all procedures. Understand your disinfectant and how it works. There is no “one size fits all” disinfectant available.
- All cultures, stocks, and other biohazardous/biomedical waste must be disposed in red biohazard bags meeting State of Florida compliance requirements and in accordance with University policy. Do not autoclave, decontaminate or treat cultures, stocks, or other biomedical or biohazardous waste prior to disposal.
- Use a secondary container to safely “transport” biological samples. Transport includes moving the samples within the lab or transporting outside of the lab.
- Clean and disinfect your biosafety cabinet before and after every procedure. Cleaning and disinfecting must include all **FIVE** interior surface areas of the biosafety cabinet: work area, rear panel, both side panels, and the sash.
- Implement a periodic disinfection schedule of equipment used to process biological samples, such as centrifuges.
- Create and maintain a readily accessible **Biohazard Spill Kit**.
- Restrict laboratory access. Only personnel working with agent should have access to the laboratory.
- Implement strict hand washing procedures. Always wash hands after removing gloves.
- No eating, drinking, smoking, applying make-up, etc. in the laboratory.
- Implement a policy for miscellaneous “lab items” such as: telephone, radio, cellular. How to use them (or not to use them) in the laboratory.
- Segregate waste properly. Do not dispose of non-contaminated material in biohazardous waste and vice versa.
- Do not crowd or clutter work area(s).

An initial risk assessment must be conducted by the PI based on the agent Risk Group classification found in the "Classification of Human Etiologic Agents on the Basis of Hazard" section of the CDC Biosafety in Microbiological and Biomedical Laboratories (BMBL).

The PI is primarily responsible for the determination of the necessary level of biosafety. EHS can provide information and assistance to aid the PI in defining this level. The use of agents requiring BSL 2 or higher must be approved by EHS and, when required, by the Institutional Biosafety Committee (IBC). Additional information can be found in the most recent version of the CDC/NIH publication, Biosafety in Microbiological and Biomedical Laboratories (BMBL).

The risk assessment process considers general environmental, agent specific and procedure specific factors. It is a qualitative rather than a quantitative process.

- Evaluation of risk in the “laboratory” environment
- Assume in principle you are dealing with an Infectious agent

Risk Assessment Process

Understanding the basic elements of biocontainment is crucial when conducting a risk assessment of any agent. The risk assessment process is used to identify:

- the hazardous characteristics of a known infectious or potentially infectious agent or material
- the activities that can result in a person’s exposure to the agent
- the likelihood that such exposure will cause a Laboratory Acquired Infections (LAI)
- the probable consequences of such an infection

Risk Factors to consider

Agent identity: Identify what agents and potential hazards are present in a given sample.

Host Range: All infectious agents have a host range. Some are limited to a particular animal host or host species while others spread to both animals and humans (zoonotic)

Pathogenicity: its capability to infect and cause disease in a susceptible human or animal host, disease in viable organisms. It varies with subtypes, strains and antimicrobial resistance among others

Infectious Dose: A very difficult parameter to obtain since infectious dose for humans that relies on studies from experimental animal models may not be relevant to humans or the available data is not very accurate

AGENT	DOSE (VIRAL PARTICLES)
EBOLA VIRUS	1(3)
TB	1-10
TULAREMIA	10
ANTHRAX	>1300???
CHOLERA	10^8
SALMONELLA TYPHI	10^5
E. COLI (ENTEROPATHOGENIC)	$10^8 – 10^{10}$
SHIGELLA	10-200
NOROVIRUS	18

Severity of the Disease its virulence as measured by the severity of disease

Preventive measures: availability of effective treatments for the disease

Lab personnel must recognize and identify the inherent hazards of working with biological agents. Perform a risk assessment process at every step of the process with the biological agent and follow a risk management routine.

Know and understand the mechanism of transmission for agent(s) being handled and the personnel risk factors that must be considered when working with a specific agent.

Routes of Exposure:

- Parenteral (needle stick, scratch)
- Exposure to non-intact skin
- Inhalation (aerosols)
- Droplet
- Ingestion
- Mucous membranes (trans dermal)
- Animal bites and scratches
- Absorption (e.g., toxins)

Lab personnel risk factors that must be considered include:

- The experience, training, and technique of lab personnel specific to the agents being handled.
- Health status of lab member(s)
- Immune suppression
- Chemotherapy
- HIV, HBV, HCV status
- Diabetes
- Pregnancy

Procedures with the biological agent

Standard microbiological laboratory practices must be implemented and followed to minimize the risk of exposure to the agent by laboratory personnel.

Examples of microbiological laboratory practices include

- Use of mechanical pipettors in the lab.
- The safe handling of sharps in the lab.
- Procedures to minimize the creation of aerosols or splashes.
- Mechanisms that can produce aerosols in the laboratory process are: pipetting, vortexing, sonicating, and blending

At the end of the day, the analysis of all these factors must be reviewed within the framework of the actual procedure(s) with the biological agent and the experience and skill level of at risk personnel.

Remember -- It is not the agent BUT what you do with the agent!

Bio-Containment

Any active biological agent in the laboratory must be properly stored and handled to avoid not only contamination and cross contamination, but losses of the agents needed for the research process.

The risk assessment process must determine not only the characteristics and requirements in the handling of the agents during the research process but also the storage and the appropriate containment to avoid exposures to laboratory employees.

Good laboratory practices and correct microbiological technique are perhaps the most important elements of bio containment.

Appropriate laboratory design *(secondary barriers)*, including the engineering structure, safety equipment *(primary barriers)* and implementation of risk management plans and these safe practices are components used to enhance the protection of laboratory personal.

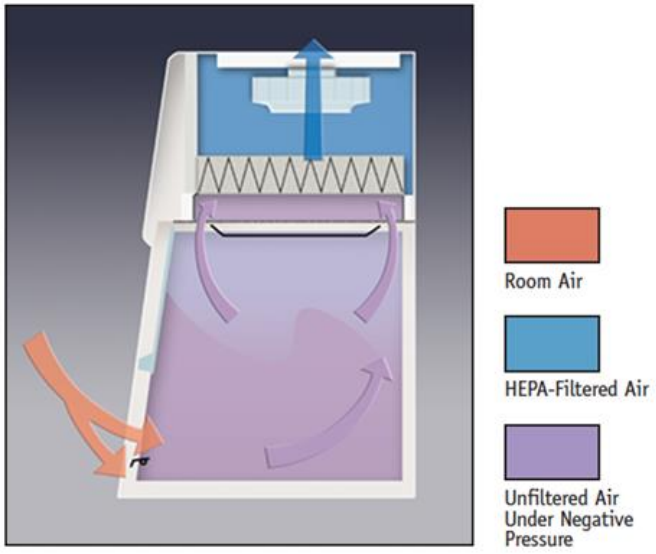
Safety equipment

Biosafety cabinets (BSCs) are the primary equipment used for containment when dealing with infectious substances that present hazards via aerosols. 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 classes of BSCs.

- Biosafety Cabinet Class I
- Biosafety Cabinet Class II
- Biosafety Cabinet Class III

BSC CLASS I

A Class I cabinet is defined as a ventilated cabinet for personnel and environmental protection. Class I cabinets do not offer product protection from contamination, significantly limiting their applications. They use unrecirculated airflow away from the operator. Class I cabinets have a similar airflow pattern to a fume hood but they also have a HEPA filter at the exhaust outlet. They may or may not be ducted outside. Class I cabinets have an inward air flow of 75-100 fpm and are not appropriate for the use of volatile/toxic chemicals/radionuclides.

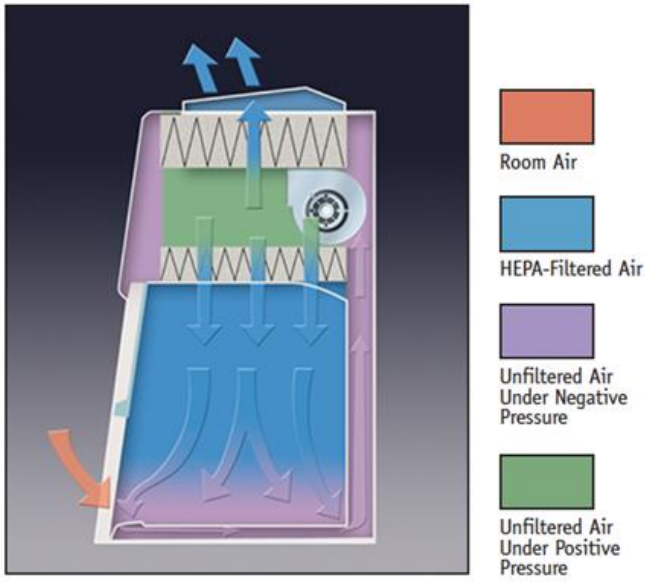


BSC CLASS II

A Class II cabinet is defined as a ventilated cabinet for personnel, product and environmental protection for microbiological work or sterile pharmacy compounding. Class II BSCs are designed with an open front with inward airflow (personnel protection), downward HEPA-filtered laminar airflow (product protection) and HEPA-filtered exhaust air (environmental protection). These cabinets are further differentiated by types based on construction, airflow and exhaust systems. The types include A1, A2, B1, B2 and C1. They require all biologically contaminated ducts and plenums to be under negative pressure or surrounded by negative pressure ducts and plenums. Type B2 cabinets take this a step further, requiring all biologically contaminated ducts and plenums to be under negative pressure or surrounded by directly exhausted negative pressure ducts and plenums.

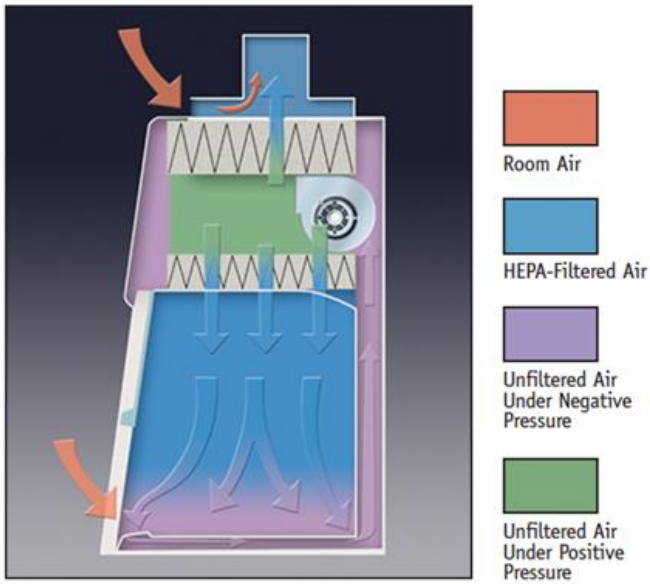
Type A1

A Class II, Type A1 cabinet must maintain a minimum average inflow velocity of 75 fpm through the sash opening. They may exhaust HEPA-filtered air back into the lab, or may be exhaust outside using a canopy connection. They are suitable for work using biological agents without volatile toxic chemicals and volatile radionuclides, but not for sterile hazardous pharmacy compounding.



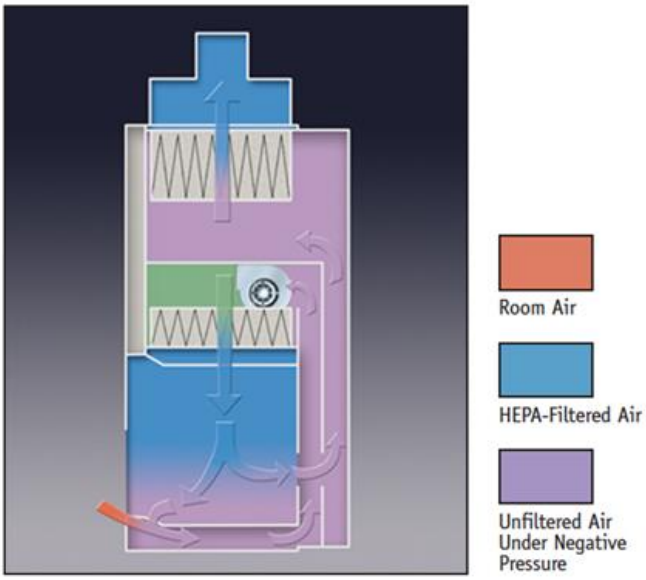
Type A2

A Class II, Type A2 cabinet must maintain a minimum average inflow velocity of 100 fpm through the sash opening. Like Type A1 cabinets, they may exhaust HEPA-filtered air back into the laboratory, or may be exhausted outside using a canopy connection. Type A2 cabinets with a canopy connection are safe for work involving biological agents treated with minute quantities of hazardous chemicals. They may also be used with tracer quantities of radionuclides that won't interfere with the work if recirculated in the downflow air.



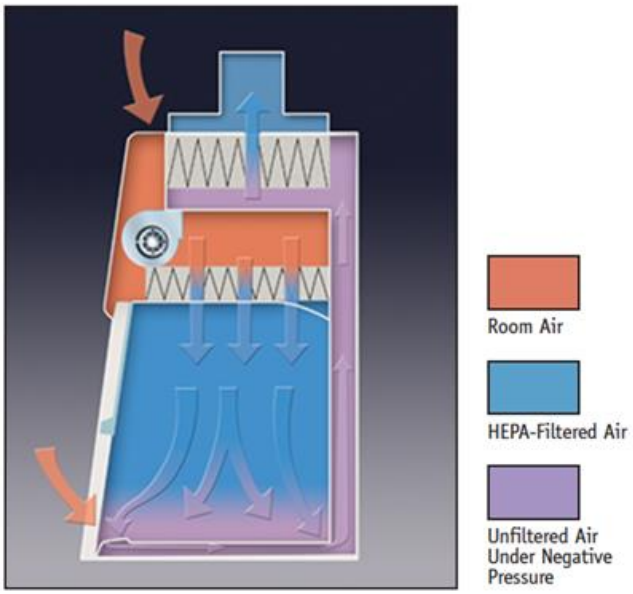
Type B1

A Class II, Type B1 cabinet must maintain a minimum average inflow velocity of 100 fpm through the sash opening. They have HEPA-filtered downflow air composed mostly of uncontaminated recirculated inflow air and exhaust most of the contaminated downflow air through a dedicated duct that exhausts outside after passing through a HEPA filter. Similar to Type A2 cabinets, Type B1 cabinets are safe for work involving agents treated with minute quantities of toxic chemicals and tracer amounts of radionuclides if the chemicals or radionuclides won't interfere with the work if recirculated in the downflow air. Unlike a Type A2, a Type B1 cabinet is also suitable for work involving minute quantities of toxic chemicals and tracer amounts of radionuclides required as an adjunct to microbiology applications as long as the work is done in the directly exhausted rear portion of the cabinet (this portion is not marked and therefore ever-changing as the airflow pattern adjusts with the loading of the cabinet's HEPA filters).



Type B2

A Class II, Type B2 cabinet must maintain a minimum average inflow velocity of 100 fpm through the sash opening. They have HEPA-filtered downflow air drawn from the lab or the outside air (not recirculated from the cabinet exhaust) and exhaust all inflow and downflow air to the atmosphere after filtration through a HEPA filter without recirculation in the cabinet or return to the lab. Because of this, they are sometimes referred to as 100% Exhaust or Total Exhaust cabinets. Type B2 cabinets are suitable for work involving biological agents treated with hazardous chemicals and radionuclides required as an adjunct to microbiology applications.

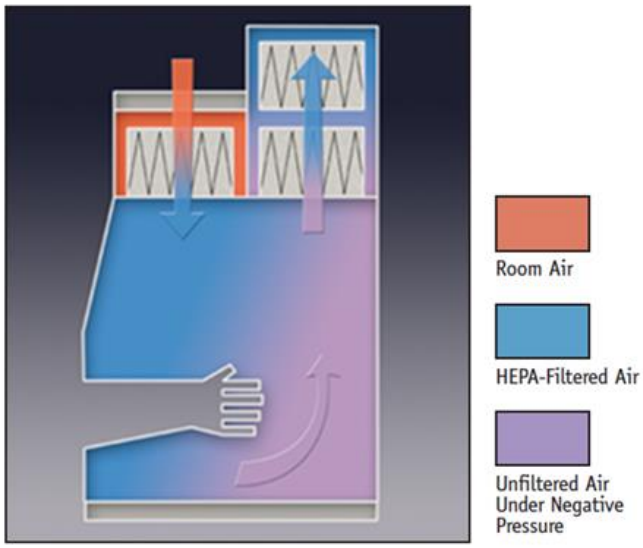


Type C1

A Class II, Type C1 cabinet must maintain a minimum average inflow velocity of 105 fpm through the sash opening. Type C1 cabinets are unique in that they can operate as either a Type A cabinet when in recirculating mode or a Type B cabinet when exhausting. C1 cabinets can be quickly changed from one mode to the other by connecting or disconnecting the exhaust and having the cabinet recertified. The Type C1 also features a marked work area with clearly delineated spaces for storage and a work area with dedicated direct exhaust for use with hazardous vapors or radionuclides.

BSC Class III

A Class III cabinet is defined as a totally enclosed, ventilated cabinet with leak-tight construction and attached rubber gloves for performing operations in the cabinet. Class III biosafety cabinets are also called glove boxes. The cabinet has a transfer chamber that allows for sterilizing materials before they leave the glove box. The cabinet is maintained under negative pressure and supply air is drawn in through HEPA filters. The exhaust air is treated with either double HEPA filtration or HEPA filtration and incineration.



Tips when using a Biosafety Cabinet

- Do not block the vents (grills)
- Do not use chemicals (unless it is a Class IIB)
- Keep working area clear of obstructions
- Position cabinet away from A/C vents, doors, and other areas of high circulation or traffic
- Periodic certification by an NSF qualified technician is required at least annually and any time the BSC is physically moved.

Establishing the basics for proper biocontainment is essential for working with any biological agent or material. You MUST:

- Conduct a risk assessment for all biological agents
- Assign a risk group to the agent
- Assign a Biosafety level to the laboratory

***Hazardous biological materials include*:**

Bacteria

- Viral agents
- Fungi
- Protozoans
- Agents produced by means such as recombinant DNA technology.

Materials, Designs and Construction

All materials, designs and construction of BSCs and laminar flow hoods shall abide by the National Sanitation Foundation (NSF) Standard 49. Performance, Inspection and Certification Every new BSC must be performance tested by the manufacturer according to the requirements listed in the NSF Standard 49 at the point of production. 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):

- Soap Bubble/Halogen Leak
- HEPA Filter Leak
- Velocity Profile
- Vibration sensitivity
- Noise level
- Airflow Smoke Patterns

In addition, each BSC must have a certificate of inspection which should include, but not be limited to, the date of certification, the name of the certifier, and the date for the next inspection. Certification of the biosafety cabinet must be done annually, whenever physically moved, or more often as necessary, whichever is sooner. Since laminar flow hoods are not used to provide protection to the operator, these devices can be certified less frequently. Contact EHS to obtain a list and information on approved and licensed certifiers.

- ENV 1-800-345-6094 http://www.envservices.com/index.asp
- MedReps 941-627-8858 http://www.medrep.us/resources/bsc.html
- MTA 977-569-8886 http://www.mtaius.com/

Laminar Flow Hoods

The term "laminar flow" describes the air purifying action of these hoods because they provide a directed, nonmixing 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 operator 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.

Recombinant and synthetic nucleic acids (NIH guidelines)

Are defined as molecules that are constructed by joining nucleic acid molecules and that can replicate in a living cell, i.e., recombinant nucleic acids; nucleic acid molecules that are chemically or by other means synthesized or amplified, including those that are chemically or otherwise modified but can base pair with naturally occurring nucleic acid molecules, i.e., synthetic nucleic acids, or molecules that result from the replication of those described in / or above.

Risk Groups (NIH Guidelines)

- **Risk Group 1 (RG1)**. Agents that are not associated with disease in healthy humans *Bacillus subtilis, Escherichia coli-K-12*
- **Risk Group 2 (RG2)**. Agents associated with human disease which is rarely serious and for which preventive or therapeutic interventions are often available. *Bacillus anthracis, Chlamydia psittaci, Legionella, Vibrio cholerae, Cladosporidium bantianum, Cryptosporidium parvum*
- **Risk Group 3 (RG3)**. Agents that are associated with serious or lethal human for which preventive or therapeutic interventions may be available (high individual risk but low community risk). *Mycobacterium tuberculosis, Yersinia pestis, Prions, HIV-1 and 2*
- **Risk Group 4 (RG4)**. Agents likely to cause serious or lethal human disease for which preventive or therapeutic interventions are not usually available (high individual risk and high community risk). *Lassa, Sabia, Ebola, Marburg virus, Herpesvirus simiae (Herpes B or Monkey B virus).*

Consideration for research involving the following must also be part of the risk assessment process
rDNA research

- Viral Vectors
    - Viral envelope is a typical unit membrane, usually from the host cell cytoplasmic membrane and contain a large amount of lipids
    - Viral nucleic acids are the infectious component of the virus , and virus inactivation is complete only when it is destroyed
    - Viruses are intra cellular parasites evolutionary designed to infect cells
    - Very efficient at transfecting their DNA into a host cell, It is then expressed to produce new viral particles
    - Replacing genes needed for the replication phase
    - Retroviruses (Lentivirus), Adenoviruses, Adeno-Associated Virus (AAV), Herpes simplex virus type 1
- Non-Viral vectors
- Cells/cell-culture
- Protein expression
- Genetically manipulated animals
- Human Subjects : IRB and IBC Reviews

Biosafety Levels (BSLs)

There are four levels (1-4) of biosafety recommended by the Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH). Each BSL outlines combinations of good laboratory practices and techniques, safety equipment, and facility designs appropriate to conduct research functions or activities with various infectious agents. A summary of the specific CDC/NIH guidelines for each BSL can be found in Table 6.

Table 6. Summary of Recommended Biosafety Levels (BSL) for Infectious Agents

BSL	Agents	Practices	Primary Barriers and Safety Equipment	Facilities (Secondary Barriers)
1	Not known to consistently cause diseases in healthy adults	Standard microbiological practices	No primary barriers required ▪ PPE: laboratory coats, gloves, eye, face protection, as needed	Laboratory bench and sink required
2	Agents associated with human disease Routes of transmission include percutaneous injury, ingestion, mucous membrane exposure	BSL-1 practice plus: ▪ Limited access ▪ Biohazard warning signs ▪ "Sharps" precautions ▪ Biosafety manual defining any needed waste decontamination or medical surveillance policies	Primary barriers: ▪ BSCs or other physical containment devices used for all manipulations of agents that cause splashes or aerosols of infectious materials ▪ PPE: laboratory coats, gloves, face and eye protection, as needed	BSL-1 plus: ▪ Autoclave available
3	Indigenous or exotic agents that may cause serious or potentially lethal disease through the inhalation route of exposure	BSL-2 practice plus: ▪ Controlled access ▪ Decontamination of all waste ▪ Decontamination of laboratory clothing before laundering	Primary barriers: ▪ BSCs or other physical containment devices used for all open manipulations of agents ▪ PPE: Protective laboratory clothing, gloves, face, eye and respiratory protection, as needed	BSL-2 plus: ▪ Physical separation from access corridors ▪ Self-closing, double-door access ▪ Exhausted air not recirculated ▪ Negative airflow into laboratory ▪ Entry through airlock or anteroom ▪ Hand washing sink near laboratory exit
4	▪ Dangerous/exotic agents which post high individual risk of aerosol-transmitted laboratory infections that are frequently fatal, for which there are no vaccines or treatments ▪ Agents with a close or identical antigenic relationship to an agent requiring BSL-4 until data are available to redesignate the level ▪ Related agents with unknown risk of transmission	BSL-3 practices plus: ▪ Clothing change before entering ▪ Shower on exit ▪ All material decontaminated on exit from facility	Primary barriers: ▪ All procedures conducted in Class III BSCs or Class I or II BSCs in combination with full-body, air-supplied, positive pressure suit	BSL-3 plus: ▪ Separate building or isolated zone ▪ Dedicated supply and exhaust, vacuum, and decontamination systems ▪ Other requirements outlined in the text

Risk group and BSL do not necessarily equate to one another. A risk assessment will determine the degree of correlation between an agent's risk group classification and biosafety level.

Sterilization

Sterilization (wet heat) is the act or process, physical or chemical, which destroys or eliminates all forms of life including microorganisms. The most dependable procedure for the destruction of all forms of microbial life:

- Autoclave
- Validation: Tape vs. Bacillus stearothermophilus
- Training for use
- Uses saturated steam
- Parameters: (15 psi / 250 oF).

- Sterilizers
- Ethylene Oxide
- Chlorine Dioxide

Chemical agents role

- Transport of the key active ingredient (radical) into the cell wall
- "break" the cell wall to produce chemical uptake
- Cell lysis
- Osmosis
- EDTA, Polymixin

Factors affecting Biocidal action

- Temperature
- pH
- Chemical demand
- Accessibility to the targeted organisms
- UV radiation
- Bacteria type
- Bacterial resistance (inherent or acquired)

Disinfectants

- Disinfectant: Physical or chemical agents that free from infection and destroys disease or other harmful microorganisms but may not kill bacterial spores
- Phenolic compounds. Recommended for killings of vegetative. Bacteria, including mycobacterium tuberculosis, fungi and lipid containing virus, ineffective against spores and most non-lipid containing virus.
- Quaternary ammonium compounds. Acceptable as general use disinfectants to control vegetative. Bacteria and non-lipid containing virus. They are not active against bacterial spores.
- Aldehydes. Effective against a wide spectrum of bacteria, fungi and viruses. Sporocidal when used properly
    - Formaldehyde solutions, 8%. Exhibits good activity against bacteria spores and viruses.
    - Formaldehyde- alcohol solutions (8% and 70%) are considered very good for disinfectant purposes because of their effectiveness against bacteria spores and viruses. For many applications, this is the disinfectant of choice.
    - Activated glutaraldehydes. Good activity but toxic.
- Iodophors. Recommended for general use (70 to 150 ppm), poor activity against bacterial spores. Rapid biocidal action. Most effective in acid solution.
- Alcohols. In concentrations 70 to 95% are good as general disinfectants, no activity against bacterial spores, fast acting.
- Hydrogen Peroxide vapor
- Periodic Acid,
- Chloride Dioxide
- Bleach solutions
    - Sodium Hydroxide, 2M solutions
    - Chlorine as active ingredient Chlorine demand
    - The free and combined available chlorine when present in the water is collectively described as
    - Total residual (available) chlorine
    - Cl2, HOCL, OCL-
    - Stability of Chlorine solutions
    - Low chlorine concentrations

- Absence of low contents of catalytic agents (Cu), (Fe)
- High alkalinity
- Low temperature
- Absence of organic material
- Storage in dark, closed containers
- % in commercial Clorox
- Reverse osmosis (RO) water

Table 7. Activity Levels of Selected Liquid Germicides[a]

Procedure/Product	Aqueous Concentration	Activity Level
Sterilization		
Glutaraldehyde	variable	
Hydrogen peroxide	6-30%	
Formaldehyde	6-8%	
Chlorine dioxide	variable	
Peracetic acid		
Disinfection		
Glutaraldehyde	variable	High – Intermediate
Ortho-phthalaldehyde	0.5%	High
Hydrogen peroxide	3-6%	High - Intermediate
Formaldehyde[b]	1-8%	High - Low
Chlorine dioxide	variable	High
Peracetic acid	variable	High
Chlorine compounds[c]	500-5000 mL/L free/available chlorine	Intermediate
Alcohols (ethyl, isopropyl)[d]	70%	Intermediate
Phenolic compounds	0.5-3%	Intermediate - Low
Iodophor compounds[e]	30-50 mg/L free iodine up to 10,000mg/L available iodine 0.1-0.2%	Intermediate – Low
Quaternary ammonium compounds		Low

Table is an adaptation of the BMBL Table 3 Activity Levels of Selected Liquid Germicides

[a]This list of chemical germicides centers on generic formulations. A large number of commercial products based on these generic components can be considered for use. Users should ensure that commercial formulations are registered with EPA or by the FDA.

[b] Because of the ongoing controversy of the role of formaldehyde as a potential occupational carcinogen, the use of formaldehyde is limited to certain specific circumstances under carefully controlled conditions (e.g., for the disinfection of certain hemodialysis equipment). There are no FDA cleared liquid chemical sterilant/disinfectants that contain formaldehyde.

[c] Generic disinfectants containing chlorine are available in liquid or solid form (e.g., sodium or calcium hypochlorite). Although the indicated concentrations are rapid acting and broadspectrum (tuberculocidal, bactericidal, fungicidal, and virucidal), no proprietary hypochlorite formulations are formally registered with EPA or cleared by FDA. Common household bleach is an excellent and inexpensive source of sodium hypochlorite. Concentrations between 500 and 1000 mg/L chlorine are appropriate for the vast majority of uses requiring an intermediate level of germicidal activity; higher concentrations are extremely corrosive as well as irritating to personnel, and their use should be limited to situations where there is an excessive amount of organic material or unusually high concentrations of microorganisms (e.g., spills of cultured material in the laboratory).

[d] The effectiveness of alcohols as intermediate level germicides is limited because they evaporate rapidly, resulting in short contact times, and also lack the ability to penetrate residual organic material. They are rapidly tuberculocidal, bactericidal and fungicidal, but may vary in spectrum of virucidal activity (see text). Items to be disinfected with alcohols should be carefully pre-cleaned then totally submerged for an appropriate exposure time (e.g., 10 minutes).

[e] Only those iodophors registered with EPA as hard-surface disinfectants should be used, closely following the manufacturer's instructions regarding proper dilution and product stability. Antiseptic iodophors are not suitable to disinfect devices, environmental surfaces, or medical instruments.

Biohazards Spill Kit

All laboratories, including Clinical labs, working with Biological Agent(s) must have a readily available Biohazards Spill kit. Place the Biohazards Spill kit(s) near the Biological Safety Cabinet (BSC) or your workstation so that they are easily accessible in the event of a spill. The supplies available in a biohazard spill kit should include, but are not limited to:

- A copy of the Spill Cleanup Protocol
- Nitrile disposable gloves (8 mil)

- Lab coat(s)
- Safety goggles
- N95 dust mask respirator(s)
- Disposable shoe covers (booties)
- Absorbent material, such as absorbent paper towels, granular absorbent material, etc.
- All-purpose disinfectant, such as normal household bleach (diluted 1:10) or an iodophor
- Autoclavable bucket for diluting disinfectant (this can be used to store the kit contents when not in use)
- Tongs and/or forceps, and/ or dustpan and hand broom or squeegee, etc. (for picking up broken glass or other contaminated sharps)
- Sharps waste container(s)
- Autoclavable red biohazard waste bags (compliant with State of Florida Chapter 64E-16* requirements
- Biohazardous spill warning signs

All non-disposable items should be autoclavable or compatible with the disinfectant to be used.
* All bags used for the collection of biomedical or biohazardous waste must comply with Chapter 64E-16, Florida Administrative Code Biomedical Waste Regulations:

- All bags must be red and have the international biological hazard symbol printed on them
- All biohazard bags must comply with impact and tearing resistance requirements set by the State of Florida
    - Impact resistance of 165 grams (determined using ASTM D-1709-91)
    - Tearing resistance of 480 grams in both the parallel and perpendicular planes with respect to length of the bag (determined using ASTM D-1922-89)

Biomedical Waste Disposal

Biomedical waste disposal is regulated by the State of Florida, not by the Federal Government. Segregation of contaminated from non-contaminated waste is the premise. Biological waste must be segregated from other types of waster at the point of origin into the following categories

Infectious, Potentially Infections, or R-DNA Biological Waste

This category includes the following:

- any material containing or contaminated with human pathogens
- any material containing or contaminated with animal pathogens
- any material containing or contaminated with plant pathogens
- any material containing or contaminated with recombinant DNA or recombinant organisms
- laboratory and clinical wastes containing human or primate blood, blood products, tissue, cell cultures, and other potentially infectious material (OPIM) including:
    - Used, absorbent materials contaminated with blood, blood products, or OPIM
    - Non-absorbent, disposable devices that have been contaminated with blood, body fluids or OPIM
- All cultures

Prior to disposal, laboratory waste containing infectious, potentially infectious, or rDNA must be inactivated either by steam sterilization (autoclaving) or chemical inactivation (e.g., treatment with household bleach).

Non-infectious Biological Waste

This category includes the following:

- Used labware (tissue culture dishes and flasks, petri dishes, centrifuge tubes, test tubes, pipettes, vials, etc.) from clinical or biomedical labs that is NOT contaminated with any of the biological wastes listed above

- Gloves used in clinical or biomedical labs that are NOT contaminated with any of the biological wastes listed above
- Disposable personal protective equipment used in clinical or biomedical labs that is NOT contaminated with any of the biological wastes listed above
- Unused medical devices
- Items contaminated with blood from animals not known to, or expected to, contain pathogens

This material does not require inactivation prior to disposal.

Note that chemically contaminated material (i.e. DNA extraction tubes contaminated with phenol/chloroform, specimen cups containing formalin, chemically contaminated gloves, etc.) must be handled as chemical waste.

Exposures

Any exposure or suspected exposure to a biological agent call Employee Health immediately at the following numbers.
305-243-3400 Monday – Friday 9am – 5pm
305-299-4584 After hours

Recombinant DNA Research

Recombinant DNA (rDNA) research procedures are regulated under the NIH Guidelines for Research Involving Recombinant DNA Molecules (NIH Guidelines). rDNA molecules are defined by these guidelines as

"molecules that are constructed outside living cells by joining natural or synthetic DNA segments to DNA molecules that can replicate in a living cell" or "molecules that can result from the replication of those described above."

Each PI proposing rDNA research must complete and submit an rDNA Questionnaire to the IBC of the University for approval.

Select Agents

Certain highly infectious and toxic agents are capable of causing substantial harm to human health and welfare. These materials are called Select Agents and are subject to federal regulation under 42CFR Part 72. The Select Agents regulation mandates that special requirements be fulfilled before a listed agent can be transferred to an institution. These requirements include

- Registration of any facility prior to receiving or transferring any of the select agents
- Submission of a form (CDC EA-101) prior to actual transfer

Research using these agents requires prior written approval from EHS. Researchers proposing the use of a listed agent must contact EHS sufficiently in advance to allow completion and approval of all required paperwork.
The list of Select Agents can be found at the CDC website http://www.selectagents.gov/

Regulations and Guidelines

- Blood borne Pathogens Standard (Exposure Control Plan)
- Tuberculosis guidelines (Infection Control Plan)
- NIH Guidelines: Recombinant DNA research
- CDC/NIH BMBL, 5th Edition
- University policy and procedures: enforce compliance with all applicable regulations
- Select Agents Regulation (42CFR§ 73)

Working with Animals

Occupational health and safety is fundamentally important to work with laboratory animals. The potential physical and health hazards that may arise from animal use in research make it necessary for laboratory workers to have the appropriate preparation and training. The Office of Protection from Research Risks (OPRR), part of the National Institutes of Health, mandates that each institution working with research animals develop and maintain health and safety programs. Principal Investigators (PIs) have the primary responsibility for implementing these programs in their research areas and for providing the preparation and training for employees under their supervision.
Before beginning research with animals at the University of Miami, PIs must first have protocols and procedures approved by the Animal Care and Use Committee (IACUC).
All activities that involve the use of live vertebrate animals at the University of Miami must be reviewed and approved under public laws and regulations promulgated by the Animal Welfare Act, the United States Department of Agriculture, and the Public Health Service. The Institutional Animal Care and Use Committee (IACUC) performs this function assuring that the animals will be treated humanely and in compliance with federal guidelines as well as determining the completeness of a PI's Standard Operating Procedures (SOPs). Each PI is responsible for developing an SOP (see the section on Standard Operating Procedures for additional information) which will address the physical hazards (bites, scratches, accidental needle sticks, etc.), allergens, and zoonoses which may be involved in his or her research. The SOP should also define the potential use of hazardous chemicals (including radioisotopes), recombinant DNA, and infectious agents. Contact EHS and the Division of Veterinary Resources (DVR) for additional assistance.

Physical Hazards
Bites and scratches are the most common physical hazards associated with laboratory animal contact. These encounters can be minimized or eliminated through proper training and handling techniques. DVR is available to provide training to research staff in the safe handling of animals. All employees working with animals must undergo this training before beginning research. Animal handling must also include the use of a minimum level of personal protective equipment. This level may include, but is not limited to, eye protection (safety glasses, face shield, etc.), gloves, surgical masks, respirators (see section on Personal Protective Equipment), proper clothing, and water resistant, closed-toe shoes.

Non-Human Primates
Those individuals working with non-human primates require special training before working with these animals. These employees must comply with special precautions which include the following:

- Annual screening for M. tuberculosis (every six months), coordinated through the Employee Health Office.
- Training on the appropriate procedures for treating animal bites and scratches.
- Training on the proper handling of primates and the appropriate use of protective clothing and equipment.
- Training addressing the potential hazards with Cercopthecine herpesvirus 1 (Herpes B Virus).

Herpes B Virus is carried by many Macaque monkeys and the infected animals are usually asymptomatic. The virus can be transmitted from monkey to man through body excretions (saliva, blood, urine, feces, etc.), needle sticks, and bites. Human infection is typically fatal. Appropriate protective clothing and eye and face protection are required and the immediate treatment of bites and scratches is critical.
Training in primate handling can be arranged by contacting one of the veterinarians in DVR.
Training on handling rodents is provided by DVR when requested.

Allergens
A significant portion of individuals who work with animals (10 to 40%) have or will develop allergies to animals. Symptoms which may develop include, but are not limited to, the following: urticaria,

conjunctivitis, rhinitis, asthma, and anaphylaxis. Individuals with a known history of allergy are encouraged to consult with EHS before beginning work.
The more common specific allergens from animals include the following:

- rat and mouse urine
- guinea pig dander, fur, saliva, and urine
- rabbit fur, saliva, and urine
- cat dander and saliva
- dog saliva and hair

Additional information on specific allergens in other species can be obtained from DVR.

Zoonoses

The transmission of zoonotic disease in the laboratory animal environment is uncommon, despite the number of animal pathogens that have the capacity to cause disease in humans. The low risk is due to (1) the improved health status of research animals developed through comprehensive programs in veterinary care and (2) the implementation of strong occupational health and safety programs. Some of the more common diseases which can effect humans and/or animals include the following:

- Monkeys: B virus, Hepatitis A, Marburg virus, pox virus, measles, and M. tuberculosis
- Rodents: lymphocytic choriomenengitis, Hantavirus, and rat bite fever.
- Cats: cat scratch fever, ringworm, and toxoplasmosis.
- All mammals: rabies.

Additional information on zoonoses in other species can be obtained from DVR.

Animal Biosafety Levels

Biosafety practices, policies and procedures for work involving animal research are similar to those used in vitro laboratory activities (see section on Biosafety). Containment of infectious materials and the limitation of exposure to contaminated animals are primarily important. Table VIII includes a summary of the biosafety levels applicable to animal research with guidelines which should be implemented for each level. Contact EHS for additional information.

Table 8. Summary of Recommended Animal Biosafety Levels for Activities in which Experimentally or Naturally Infected Vertebrate Animals are Used

BSL	Agents	Practices	Primary Barriers and Safety Equipment	Facilities (Secondary Barriers)
1	Not known to consistently cause diseases in healthy adults	Standard animal care and management practices, including appropriate medical surveillance programs	As required for normal care of each species ▪ PPE: Laboratory coats, gloves, eye, face protection, as needed	Standard animal facility: ▪ No recirculation of exhaust air ▪ Directional air flow recommended ▪ Hand washing sink is available
2	▪ Agents associated with human disease ▪ Hazard: percutaneous injury, ingestion, mucous membrane exposure	ABSL-1 practice plus: ▪Limited access ▪Biohazard warning signs ▪"Sharps" precautions ▪Biosafety manual ▪Decontamination of all infectious wastes and animal cages prior to washing	ABSL-1 equipment plus primary barriers: ▪ Containment equipment appropriate for animal species ▪ PPE: Laboratory coats, gloves, face, eye and respiratory protection as needed	ABSL-1 plus: ▪Autoclave available ▪Handwashing sink available ▪Mechanical cage washer recommended ▪Negative airflow into animal and procedure rooms recommended
3	Indigenous or exotic agents that may cause serious or potentially lethal disease through the inhalation route of exposure	ABSL-2 practice plus: ▪Controlled access ▪Decontamination of clothing before laundering ▪Cages decontaminated before bedding is removed ▪Disinfectant foot bath as needed	ABSL-2 equipment plus: ▪ Containment equipment for housing animal and cage dumping activities ▪ Class I, II or III BSCs available for manipulative procedures (inoculation, necropsy) that may create infectious aerosols ▪ PPE: Laboratory coats, gloves, face, eye and respiratory protection as needed	ABSL-2 plus: ▪ Physical separation from access corridors ▪ Self-closing, double-door access ▪ Sealed penetrations ▪ Sealed windows ▪ Autoclave available in facility ▪ Entry though ante-room or airlock ▪ Negative airflow into animal and procedure rooms ▪ Hand washing sink near exit of animal or procedure rooms
4	▪ Dangerous/exotic agents which post high individual risk of aerosol transmitted laboratory infections that are frequently fatal, for which there are no vaccines or treatments ▪ Agents with a close or identical antigenic relationship to an agent requiring BSL-4 until data are available to redesignate the level ▪ Related agents with unknown risk of transmission	ABSL-3 practices plus: ▪ Entrance through change room where personal clothing is removed and laboratory clothing is put on; shower on exiting ▪ All wastes are decontaminated before removal form the facility	ABSL-3 equipment plus: ▪ Maximum containment equipment (i.e., Class III BSC or partial containment equipment in combination with full body air-supplied positive-pressure suit) used for all procedures and activities	ABSL-3 plus: ▪ Separate building or isolated zone ▪ Dedicated supply and exhaust, vacuum, and decontamination systems ▪ Other requirements outlined in the text

Immunizations

If planning to work with animals inoculated with an infectious agent to human or with possibilities of a zoonotic event, and there is a vaccine available, it is required to have the immunizations before commencement of activities with such and infectious agent.

Employee Health

The purpose of the Employee Health Program is to monitor the occupational health of the University of Miami community. This includes informing relevant personnel of federal mandates relating to employee health, training employees on appropriate policies and procedures, and inspecting clinical areas routinely to ensure compliance with University policy and federal regulations. The primary policies addressed by this program are the Bloodborne Pathogens Policy and Procedures, the Tuberculosis (TB) Infection Control Policy and Procedures and the Occupational Health Program for Animal Research Personnel Policy.

Bloodborne Pathogens Policy and Procedures (Exposure Control Plan)

The purpose of the Exposure Control Plan is to comply with OSHA's Bloodborne Pathogens Standard, 29 CFR§1910.1030. The plan is designed to eliminate or minimize occupational exposure of employees to bloodborne pathogens and other potentially infectious materials.

The Exposure Control Plan includes mandated implementation of exposure determination and risk assessment, training, notification of employees' rights, Standard Precautions (formerly known as Universal Precautions), engineering controls, personal protective equipment, and medical surveillance. For specific information regarding laboratory compliance with the Exposure Control Plan, contact EHS. The Hepatitis B Virus (HBV) is the major infectious occupational hazard in the health-care industry. Despite the similarities in the modes of transmission, the risk of HBV infection in the health-care environment far exceeds that for other viruses of great concern, such as the Human Immunodeficiency Virus (HIV) and Hepatitis C Virus (HCV). All chemicals used to inactivate these viruses must be tuberculocidal and EPA approved.

Standard Precautions

As a result of the occupational hazards presented by HBV, HCV, HIV, and other infectious materials, Standard Precautions must be implemented. These include the treatment of all activities involving contact with blood, tissue and body fluids (including the handling of contaminated or potentially contaminated equipment or materials) as if dealing with contaminated infectious material.
The following standards of practice must be observed and conspicuously posted near first aid equipment and in all areas where the possibility of contamination by infected materials may occur:

- Hands must be washed if there is any likelihood of contact with blood, body fluids or human tissue. If soap and water are not immediately available, an antiseptic towelette shall be used as an interim measure.
- Gloves shall be worn when breaks in the skin are present or when contact with any of the following is anticipated: blood, body fluids, tissues, mucous membrane or contaminated surfaces.
- An impervious gown or apron shall be worn when splattering of clothing is likely to occur.
- If splattering, atomization or aerosolization is anticipated, appropriate protective equipment (face shield, eye protection, etc.) shall be worn at all times.
- Emergency personnel must have mouthpieces, resuscitation bags and other resuscitation devices for use in areas where the need for resuscitation is likely.
- Sharp objects shall be handled carefully.

Post Exposure Evaluation

The department and the Principal Investigator (PI) must make available to all employees who have had an exposure incident, post exposure evaluation and follow up at no cost to the employee. Following an exposure incident, the employee must immediately notify EHS who will make the necessary arrangements for confidential medical evaluation and follow up. The immediate notification of EHS is absolutely necessary to determine the need for emergency medications which are most effective within two hours of exposure. EHS can be contacted for exposure incidents on a twenty-four hour basis.

Table 9. Examples of Disinfectants

Recommended Agents[1]	Minimum Concentration	Effective Concentraton
Sodium hypochlorite	0.02%	0.5%
Sodium hydroxide	30mM	30mM
B propriolactone	1:400 dilution	1:400 dilution
Hydrogen peroxide	0.3%	1%
Ethyl alcohol	25%	50%
Isopropyl alcohol	30%	50%
Lysol	0.5%	1%
NP-40 detergent	1%	1%
Quaternary ammonium chloride	0.08%	1%
Acetone/alcohol mix	1:1	1;1

[1]Recommended concentrations may be higher than minimum effective concentrations to assure potency of these agents during laboratory usage conditions.

Tuberculosis (TB) Infection Control Policy and Procedures

OSHA requires the University to perform TB screening of all Health Care Workers and applicants who have been offered employment. The policy of the University is to screen all employees and "new hires" (including physicians, faculty, and temporary employees) on the Medical Campus, and any other employees who are assigned to areas or buildings where patients or human subjects are seen. Screening of non-health care workers is required secondary to recirculating air in buildings or areas where persons with TB may receive healthcare.

Active Employee Screening Procedures

- TB Screening will be done in accordance with the current Tuberculosis Infection Control Policy. Screening will be done more frequently in areas deemed high-risk by EHS.
- Employees will receive testing at the Employee Health Office (contact EHS for the testing schedule) unless otherwise specified. At the time of testing, the employee will be given an appointment to return for reading after 48 hrs. Any employee who fails to return for reading will be required to be retested in two weeks.
- Employees who have tested positive in the past, and have written proof, will not be retested. These employees will, however, be required to complete a questionnaire asking about the various symptoms of TB. Individuals exhibiting symptoms may be required to obtain a chest X-ray at University expense. The need for X-ray will be evaluated by the Employee Health Manager on a case-by-case basis.
- BCG vaccine is not an acceptable substitute for the screening process. BCG vaccine is not used in the USA and, because of the variability of the vaccines used throughout the world, the efficacy of the procedure is questionable. Additionally, if the vaccine does produce immunity in an individual, that immunity is generally short lived (less than 10 years). An individual vaccinated in childhood and skin test (PPD) positive in adulthood is more likely to be positive secondary to exposure to TB than to immunity from the vaccine. Therefore, any BCG vaccinated employee unable to present written medical documentation that he or she has had a positive PPD in the last 10 years will be tested. If a medical document showing proof of a positive PPD in the last ten years is presented, the employee will not be retested, but will be screened as noted above.
- All individuals who may have been exposed to TB must report the exposure to EHS for post exposure evaluation. In addition, any individual exhibiting symptoms of TB must be reported to EHS immediately.

The Occupational Health Program for Animal Research Personnel Policy

The purpose of this policy is to provide an occupational health program for employees performing work duties with animals and to comply with the recommendations of the National Institutes of Health's Office

of Laboratory Animal Welfare (NIH OLAW).
Employees working in a University laboratory or have contact with research animals should contact the Employee Health Office at ohp@miami.edu to complete the required forms and evaluation for this Occupational Health Program.
It is the policy of the University of Miami to offer the following occupational health services to covered employees:

- Annual audiogram for employees in the hearing conservation program
- Annual respiratory protection training and fit testing for employees who are authorized to wear Respirators.
- Annual tuberculosis screening. Semi-annual screening may be required for contact with some animal species.
- Baseline health assessment.
- Exposure incident medical evaluation and follow-up.
- Follow-up health assessment, as required.
- Pregnant woman counseling.
- Vaccinations, laboratory tests, and titers as required according to the need of the individual and the animal species for which there is contact.

New Hire Screening Procedures
The new hire screening procedures include:

- Upon offer of employment, applicants shall be informed of the requirement of TB screening before reporting for work. If an applicant has been tested in the past twelve months, written documentation must be provided to the Employee Health Office. Applicants must report to the Employee Health Office regardless of past history of TB screening. Testing cannot be performed on Thursdays or Fridays due to the requirement for reading in 48 hrs after testing. All NEW HIRES must be sent for screening, including those who claim they have tested positive in the past or those who report having had BCG vaccine. Those who have tested positive in the past will not be required to be retested. However, they must complete a screening form, and may be required to have a chest X-ray at University expense. The need for X-ray will be evaluated by the Employee Health Manager on a case-by-case basis.
- Applicants must be read 48 hours after initial testing. At the time of testing the applicant will be given an appointment to return for a reading of the test. Any applicant who FAILS TO RETURN FOR THIS READING MAY NOT BEGIN EMPLOYMENT DUTIES.
- Any applicant with positive test results will be required to obtain a chest X-ray (at University expense). The applicant will NOT BE ALLOWED TO REPORT FOR WORK UNTIL THE RESULTS OF THE XRAY ARE KNOWN BY THE EMPLOYEE HEALTH OFFICE TO BE NEGATIVE. This generally will take no longer than 24 hrs.
- Applicants with positive chest X-rays will be further evaluated. Any applicant with positive chest X-ray results will be referred to the Public Health Department for further evaluation as required by law, and WILL NOT BE ALLOWED TO REPORT FOR WORK UNTIL CLEARED BY THAT AGENCY.
- Applicants who cannot verify previous TB screening will be subject to further testing. Any applicant who CANNOT present proof of testing within the previous twelve months, WILL BE REQUIRED TO BE TESTED A SECOND TIME IN TWO WEEKS (the Two-Step Method for screening for TB). This is done to prevent future confusion if, the then employee, should have a positive test. The Two-Step testing procedure will NOT delay an applicant from beginning work duties; however, any applicant who fails to appear for the second round of testing may be subject to disciplinary action.

Laser Safety

The laser safety program at the University of Miami is designed to ensure all laser users complies with Federal and State regulations. These regulations include FAC Chapter 10D-89, 21 CFR§1040, and ANSI Z136.1. Lasers are categorized into different safety classifications (Classes 1-4) depending upon power output, wavelength, and accessibility to the beam by the operator. The Laser Safety Program regulates research use lasers at the University of Miami. This program includes requirements on the purchase, acquisition, transfer, movement and registration of lasers. The program also includes training, medical surveillance, and certification of operators. All Class 3B and 4 lasers must be registered with EHS using the Laser Registration form on ehs.miami.edu, or by contacting the LSO at 305-243-3400. Appropriate safety goggles must be worn at all times within the Laser room.

Any accident or suspected accident with the laser immediately go to the nearest emergency room for examination. Accidents on medical campus should go to the Bascom Palmer Eye Institute emergency room.

Bascom Palmer Eye Institute emergency room, located on the 2nd floor
900 NW 17th St
Miami, FL 33136
Phone 305-326-6170

All accidents and near misses must be reported to the Laser Safety Officer at 305-243-2400.

The Principal Investigator is responsible for ensuring compliance with the Laser Safety Program, registering the lasers with EHS and for coordinating all laser activities with the Laser Safety Officer (LSO).

Contact EHS 305-243-3400 for additional information including issues concerning personal protective equipment (required protective eyewear), standard operating procedures, and training schedules.

Fire Safety

Guidelines and regulations on fire safety in the laboratory are derived from the National Fire Protection Association (NFPA) 45 Standard Fire Protection for Laboratories Using Chemicals. NFPA 45 applies to all laboratory buildings, units, and work areas in which hazardous chemicals are handled or stored. Although each laboratory setting can be unique, NFPA 45 provides basic requirements for the protection of life and property as well as the control of fires and explosions involving the use of chemicals in laboratory-scale operations.

Laboratories are classified as Class A (high fire hazard), Class B (moderate fire hazard), Class C (low fire hazard), or Class D (minimal fire hazard), according to the quantities of flammable and combustible liquids contained within the unit, both stored and used (see the section on Chemicals, Table III). The classification also defines the required fire alarm systems and smoke detection devices, type of construction, and the maximum quantity of chemicals that can be stored or contained per square foot of laboratory area.

Emergency Egress and Evacuation

The Principal Investigator must be familiar with emergency procedures, including evacuation plans, for the laboratory and should periodically review these procedures with employees. Laboratory personnel must keep traffic areas free of obstacles and obstructions. Chemicals must be stored properly on shelves and in cabinets and not on the floor. Exits from laboratories must be kept clear and unobstructed to provide full instant use in the event of fire or other emergency. The hallways outside each laboratory must not be used for storage or office space. These areas must be kept free and clear to provide emergency egress during an evacuation.

If the fire alarm is activated it must be treated as a fire event and everyone is to evacuate using the nearest exit and assemble at the designated meeting site. Handicapped individuals are to be escorted into the exit stairwell landing if located above the ground floor and fire rescue personnel must be advised of their location upon arrival to the building.

In case of fire, remember **RACE**:

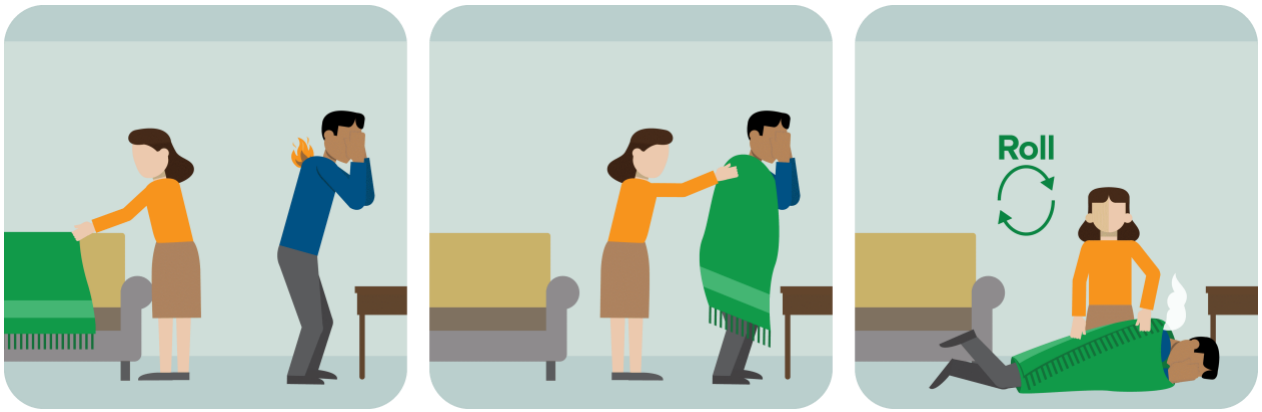
R **Rescue** persons in immediate danger
A **Alert** others by activating the building fire alarm and calling 911
C **Confine** the fire by closing doors
E **Extinguish*/Evacuate** to the designated meeting site

*****Any attempt to extinguish the fire must only be done after the building fire alarm and 911 response have been activated, the fire is small and contained, the appropriate extinguisher is available, and the user has been trained on how to use a fire extinguisher. If the fire cannot be extinguished after using one fire extinguisher, close all doors and evacuate the building. Assemble at the designated meeting site.

STOP, DROP and ROLL

If you or your clothes catch fire, stop, drop and roll. Stop, drop to the ground, and cover your face with your hands. Roll over and over or back and forth until the fire is out.

If you cannot stop, drop and roll, use a fire blanket to help you or others smother the flames. Cover the person with the blanket to smother the fire.



Fire Safety Devices

There are a variety of safety devices designed to deal with fire emergencies. These devices can be categorized into two basic types: fixed and portable.

Fixed Devices

These include fire alarms, pull stations, standpipes, fire hoses, smoke detectors, and automatic sprinkler systems. They are designed to provide automated detection (smoke detectors) and emergency containment (automatic sprinkler systems) for the laboratory as well as to assist trained emergency response personnel (standpipes and fire hoses) in dealing with fires. Pull stations should be activated by laboratory personnel only in the case of a fire emergency.

Portable Devices

The primary portable fire safety device is the fire extinguisher and shall comply with NFPA 10 Standard Installation of Portable Fire Extinguishers. These devices are designed to extinguish only incipient fires. Every laboratory must have a fire extinguisher within at least 50 feet unless otherwise specified and conspicuously located – readily accessible and available in the event of a fire. The fire extinguisher must be of the capacity and class appropriate to the volume and type of chemicals used in the specific laboratory. Fire extinguishers must also be inspected annually by qualified personnel, and visually checked by maintenance personnel on a monthly basis.

Fire extinguishers are classified as follows:

A		Ordinary Combustibles	Wood, Paper, Cloth, Etc.
B		Flammable Liquids	Grease, Oil, Paint, Solvents
C		Live Electrical Equipment	Electrical Panel, Motor, Wiring, Etc.
D		Combustible Metal	Magnesium, Aluminum, Etc.
K		Commercial Cooking Equipment	Cooking Oils, Animal Fats, Vegetable Oils

To use a fire extinguisher, remember **PASS**:

P Pull the pin
A Aim at the base of the fire
S Squeeze the handle
S Sweep from side to side

Never throw water on electrical fires (Class C) or flammable liquids (Class B).

All fire extinguishers in the laboratories are rated for Class A, B and C fires. For those laboratories using combustible metals, Class D fire extinguishers will be provided or contact EHS to have them installed.

Once a fire extinguisher has been used, it must be removed from service to be recharged – contact Facilities Work Control for assistance.

For additional information on the development of evacuation plans, and practical training on how to use fire extinguishers, contact EHS at 305-243-3400.

Electrical Safety
It is important for all laboratory personnel to understand their electrical needs and not overload the electrical systems in the building. Contact Facilities Work Control for an assessment or modification to the laboratory's electrical needs or requirements.

Electrical Cords
All electrical equipment should be checked regularly for wear and tear. Any equipment with damaged cords or plugs must be removed from service and reported for repairs or replacement. Electrical cords must not be affixed to structures; extend through walls, ceilings, or floors, or under doors or floor coverings; or be subject to environmental or physical damage.

Extension Cords
The use of extension cords is allowed for a period not to exceed 90 days. They are to be plugged directly into an approved receptacle and shall, except for approved multi-plug extension cords, serve only one portable appliance. The ampacity of the extension cords shall not be less than the rated capacity of the portable appliance supplied by the cords and shall be maintained in good condition without splices, deterioration, or damage. The extension cords shall be grounded when servicing grounded portable appliances and shall not be "daisy-chained"; or affixed to structures; extend through walls, ceilings, or floors, or under doors or floor coverings; or be subject to environmental or physical damage. Extension cords shall not be used as a substitute for permanent wiring. (Source: NFPA 1, Fire Code, Chapter 11).

Surge Protectors
The use of surge protectors is allowed for all electrical equipment in laboratories that do not require an uninterrupted power supply (UPS). For equipment that require UPS, these must be plugged directly

into the red outlets. The University's recommended surge protector is Tripp-Lite: hospital/medical grade.

Ground Fault Circuit** Interrupters **(GFCI)

GFCIs outlets are fast-acting circuit breakers designed to shut off electric power to prevent electrocution from an electrical system. They are located in all wet or damp locations such as sinks, bathrooms, showers etc. Important laboratory equipment such as freezers and refrigerators that require UPS must not be plugged into GFCI outlets.

Glossary

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

Anhydride - Any compound, often an acid, 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.

Asphyxia - Oxygen deprivation to the body, causing unconsciousness or death, also known as suffocation.

Asphyxiant – A substance that can cause unconsciousness or death by suffocation.

Auto ignition temperature - The lowest temperature at which a substance will spontaneously ignite in a normal atmosphere without an external force of ignition.

Base – A substance that donates electrons or hydroxide ions, or accepts protons. A base has a pH of >7. Examples of bases include calcium carbonate, sodium hydroxide, and sodium carbonate.

BCG - Bacille of Calmette-Guérin. Tuberculosis vaccine used in some foreign countries with a high prevalence of TB.

Biodegradable - The capability of being readily decomposed by bacteria or other living organism.

Biomedical waste - Any solid or liquid waste which may present a threat of infection to humans as defined by the State of Florida.
http://www.leg.state.fl.us/statutes/index.cfm?App_mode=Display_Statute&URL=0300-0399/0381/Sections/0381.0098.html

Biomedical waste disposal bags (red bags) - These are the only approved biomedical waste disposal bags used at the University of Miami. All other types are not approved in the state of Florida.

Blood borne Pathogens Policy and Procedures - The University's Exposure Control Plan, designed to eliminate or minimize occupational exposure of employees to blood borne pathogens

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 oF; gasoline, BP = 100 oF.

BTU - British Thermal Unit - The quantity of heat required to raise the temperature of 1lb of H_2O by 1^oF.

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 Abstract Service 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.

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

Corrosive - A substance 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.

Dermal toxicity - Adverse effects resulting from skin contact to a material. Often used to denote effects on experimental animals.

Designated Area - A separate and distinct portion of a laboratory designed to deal with extremely hazardous chemicals and other substances which 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 EHS.

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 – Capable of catching fire and burn easily. See also Combustible

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 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 High-Efficiency Particulate Air-purifying filter equipment, used for removing 99.97% of airborne particles. HEPA are used in BSCs to filter the air.

Immunocompromised - The state in which the immune system is compromised or absent because of disease or drugs. Individuals who are immunocompromised are less capable of battling infections due to the immune system not working accurately. Examples of immunocompromised people are those with HIV/AIDS, pregnant women and those undergoing chemotherapy.

Incompatible - Substances that can cause undesirable conditions when mixed together or stored in close proximity. This term usually refers to substances that will cause a rapid threat to health and safety. Examples of incompatible substances are acids and azides, nitrates and Sulphuric acid, and sodium and water.

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.

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

Nanoparticles – Microscopic particles with a diameter between 1 and 100 nanometers (nm) in size.

Nanotechnology – The manipulation of matter on a near-atomic scale. One nanometer (nm) is 1 billionth of a meter (10-9m).

Odor threshold - Concentration of an odorous gas or vapor at which only half of a panel of test subjects (the 'sniffers') can detect the smell.

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, solid, liquid, or gas, at a given temperature.

Post Exposure Prophylaxis – A preventative medical treatment started immediately after exposure to a pathogen.

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 (usually for 8-hr work shifts).

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 tract are the most commonly affected areas in the body by chemical sensitizers.

Sharps – Objects, including needles and pipette tips, capable of puncturing, lacerating, or otherwise penetrating the skin.

Sharps container - A rigid, leak and puncture resistant container, designed primarily for the containment of sharps, clearly labeled with the phrase and international biological hazard symbol as described in section 64E-16.004(2)(a), F.A.C., and manufactured with dyes meeting the requirements for incidental metals as described in section 64E- 16.004(2)(b)1.b.,F.A.C.

SDS - **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. Previously known as MSDS

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 infectious agents.

Specific gravity - The ratio of the mass of a body to the mass of an equal volume of water at 4oC or other specified temperature.

Target organ – A specific organ on which a toxin, chemical, drug or other substance acts upon.

TB - Tuberculosis. An infectious disease usually caused by Mycobacterium tuberculosis (MTB) bacteria. Tuberculosis generally affects the lungs, but can also affect other parts of the body.

TCLo - **T**oxic **C**oncentration **Lo**w. 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 - **T**hreshold **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:

- **TLV-TWA**, the allowable **T**ime-**W**eighted **A**verage concentration for a normal 8-hour workday or 40-hour week;
- **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
- **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 - **U**pper **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.

Standard Precautions - The treatment of all human blood and certain human body fluids as if they are known to be infectious for HIV, HBV, and other blood borne pathogens. Formerly known as Universal Precautions.

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.