ARKANSAS STATE UNIVERSITY
GOVERNING PRINCIPLES AND PROCEDURES FOR LABORATORY SAFETY

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1.0 INTRODUCTION

Arkansas State University (ASU) is committed to safeguarding the health and well-being of its employees, students, and affiliated workers who use hazardous materials for educational or research purposes.

2.0 PURPOSE

These policies and procedures have been written to establish standards of use and to clearly articulate responsibilities at every level.

3.0 DEFINITIONS

Aerosol. An aerosol is composed of solid or liquid particles of microscopic size dispersed in a gaseous medium. The toxic potential of an aerosol is only partially described by its concentration in milligrams per cubic meter (mg/m3). For a proper assessment of the toxic hazard, the size of the aerosol's particles is important. Particles above l micrometer tend to deposit in the upper respiratory tract. Below l micrometer particles enter the lung. Very small particles (<0.2 m) are generally not deposited.

Anesthetics, Primary. Primary Anesthetics have a depressant effect upon the central nervous system, particularly the brain. Examples include: Halogenated hydrocarbons, Alcohols

Asphyxiants. Asphyxiants have the ability the deprive tissue of oxygen.

Asphyxiants, Simple. Simple asphyxiants are inert gases that displace oxygen. Examples include: Nitrogen, Nitrous oxide, Carbon dioxide, Hydrogen, Helium

Asphyxiants, Chemical. Chemical asphyxiants have as their specific toxic action rendering the body incapable of utilizing an adequate oxygen supply. They are active at very low concentrations (few ppm). Examples include: Carbon monoxide, Cyanides

Biohazardous Materials. Infectious agents or hazardous biological materials that present a risk or potential risk to the health of humans, animals or the environment. Biohazardous materials include certain types of recombinant DNA; organisms and viruses that are infectious to humans;

animals or plants (e.g., parasites, viruses, bacteria, fungi, prions, rickettsia); and biologically active agents (e.g., toxins, allergens, venoms) that may cause disease in other living organisms or cause significant impact to the environment or the community.

Carcinogen. Carcinogen commonly describes any agent that can initiate or speed the development of malignant or potentially malignant tumors, malignant neoplastic proliferation of cells, or that possesses such material. Known human carcinogens include: Asbestos, 4-Nitrobiphenyl, Alpha-napthylamine, Methyl cloromethyl ether, 3,3'-dichlorobenzidine, Bis-chloromethyl ether, Vinyl chloride, Inorganic arsenic, Ethylene oxide, 1,2-dibromo-3-chloropropane, N-nirosodimethylamine, (DBCP), Coal tar pitch volatiles. For additional information, reference the National Toxicology Program, *Annual Report of Carcinogens*, National Toxicology Program (latest edition), *Monographs*, International Agency for Research on Cancer, (latest edition), and *Toxic and Hazardous Substances*, OSHA, 29CFR1910, Subpart Z.

Chemicals as Hazardous Waste. A chemical is defined as a hazardous waste if it is one of the listed chemicals in 40 CFR Ch. I § 261.33, is corrosive (Ph > 12.5 or pH < 2.0), or is flammable (flash point > 140Ï F) or is reactive.

Concentration (Amount of Agent). Concentration is the number of infectious organisms per unit volume. As the viable agent concentration and volume increases, the risk potential gets higher. The media/reservoir, laboratory activity, volume (especially >10 liters) need to be considered in risk determination.

Direct (Skin/Eye) Contact Hazards.: Direct contact to biohazardous materials occurs through cross-contamination and mucous membrane exposure including the skin, eyes, inside of the mouth, nose, and the genitals. The main avenues by which biohazardous materials enter the body through the skin are hair follicles, sebaceous glands, sweat glands, and cuts or abrasions. Examples of how ingestion occurs include:

- Splash or spray of biohazardous material onto skin, eye, mouth, or nose;
- Handling contaminated equipment with unprotected non-intact skin;
- Transfer or rubbing by contaminated fingers or gloved hand; or
- Applying cosmetics or contact lens in laboratory

Gas. Gas is a substance which is in the gaseous state at room temperature and pressure.

Hazardous Chemical (Substance). Any element, chemical compound, or mixture of elements or compounds, which is a physical hazard or a health hazard.

Hazardous Waste. A chemical is defined as a hazardous waste if it is one of the listed chemicals in 40 CFR Ch. I § 261.33, is corrosive (Ph > 12.5 or pH < 2.0), or is flammable (flash point > 140Ï F) or is reactive.

Health Hazard. A health hazard is defined as: a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. Included are: toxic, highly toxic, carcinogens, irritants, reproductive toxins, corrosives, sensitizers, radioactive materials, neurotoxins (nerve), biohazards, heptotoxins (liver), nephrotoxins (kidney), agents that act on the hematopoietic system (blood), agents that damage the lungs, skin, eyes, or mucus membranes.

Infectious Dose. The infectious dose is the number of microorganisms required to initiate an infection. This dose can range from one to hundreds of thousands of units depending on agent, exposure route, virulence, and host immune status or susceptibility for the disease.

Ingestion Hazards. Ingestion of biohazardous materials occurs frequently as the result of poor personal hygiene and poor laboratory practice. Proper hand washing minimizes the opportunity for mouth and eye exposures. Examples of how ingestion occurs include:

- Eating, drinking, and smoking in laboratory;
- Mouth pipetting and suction techniques; or
- Transfer of microbes to mouth by contaminated fingers or articles.

Inhalation Hazards. Inhalation of aerosolized biohazardous materials is the most common route of entry into the body. Inhalation of aerosols involves microscopic solid or liquid particles small enough to remain dispersed and suspended in air for long periods. Sources of aerosols include:

- Aerosolized solid material (spores, dust, particulate, etc.).
- Liquid material (mists and sprays, coughing, spittle, sputum, etc.).
- Technical process (blending, grinding, sonicating, lyophilizing, sawing, centrifuging, etc).

Injection or Inoculation Hazards. Inoculation or injection occurs when biohazardous material is accidentally introduced into the body with contaminated objects through the intact skin barrier. Inadequate control of sharp instruments and infected animals or arthropod vectors usually results in accidental inoculation or injection. Examples of injection and inoculation hazards include:

- Inoculation with hypodermic needles, broken glassware, scalpels, or other sharp instruments;
- Sharps injuries (needle sticks, glass pipettes, syringes, etc.); or

- Animal bites, scratches, kicks, abrasions, punctures.

Immune Status: Immune status is the current condition of a living organism to resist and overcome infection or disease. The primary function of the immune system is to protect the body from foreign substances by an acquired ability to distinguish self from non-self. Host susceptibility or immune status helps determine the level of risk of acquiring a disease upon exposure. CDC and NIH guidelines presume a population of immunocompetent individuals.

Irritants. Irritants are materials that cause inflammation of mucous membranes with which they come in contact. Inflammation of tissue results from concentrations far below those needed to cause corrosion. Long term exposure to irritants can result in increased mucous secretions, chronic bronchitis, or changes in the mechanics of respiration and lung function. Examples include: Ammonia, Alkaline dusts and mists, arsenic trichloride diethyl/dimethyl sulfate, hydrogen chloride, hydrogen fluoride, halogens, nitrogen dioxide, ozone, phosgene, phosphorus chlorides, sulfur dioxide, acetic acid, formaldehyde, formic acid, sulfuric acid, acrolein, iodine.

Irritant, Primary. A primary irritant has systemic toxic action either because the products formed on the tissue of the respiratory tract are non-toxic or because the irritant action is far in excess of any systemic toxic action. Example: hydrogen chloride.

Irritant, Secondary. A secondary irritant's effect on mucous membranes is over-shadowed by a systemic effect resulting from absorption. Examples include: Hydrogen sulfide, Aromatic Hydrocarbons. Exposure to a secondary irritant can result in pulmonary edema, hemorrhage and tissue necrosis.

Material Safety Data Sheets (MSDS). A Material Safety Data Sheet (MSDS), prepared in accordance with OSHA Hazard Communications Standards, is a document that is repared by the manufacturer explaining the nature of the hazard and its safe handling.

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

Recombinant DNA Molecules. *NIH Guidelines* characterize these molecules as those constructed outside of living cells by joining natural or synthetic DNA segments to DNA molecules that can replicate in a living cell, or molecules that result from their replication.

Registered User. The registered user is typically the Principal Investigator or Supervisor of a project that includes the use of biohazardous materials.

Responsible Official. The individual designated by an entity to act on its behalf. This individual must have the authority and control to ensure compliance with federal regulations.

Routes of Entry. An infection occurs when pathogenic microorganisms enter the human body in sufficient numbers and by a particular route, which overcomes the body's defense system. By understanding the mode of transmission (pathway from source to you) and route of entry (entry route into body), procedures or controls to prevent exposure and infection can be developed.

Sensitizer. A sensitizer causes a substantial number of exposed workers to develop an allergic reaction in normal tissue after repeated exposure. The reaction may be as mild as a rash (contact dermatitis) or as serious as anaphylactic shock. Examples include: Epoxies, Nickel Compounds, Poison ivy, Toluene di-isocyanate, Chromium compounds, Chlorinated hydrocarbons.

Toxicity. Toxicity is the study of the nature and action of poisons. Specifically, it is the ability of a chemical molecule or compound to produce injury once it reaches a susceptible site in or the body.

Toxicity Hazard. Toxicity Hazard is the probability that injury will occur considering the manner in which the substance is used.

Unaffiliated Worker. Individuals who work with biohazardous materials who are not formally affiliated with the University; e.g., faculty members on sabbatical, employees in start-up companies, etc.

Vapor. A vapor is the gaseous phase of a material which is ordinarily a solid or a liquid at room temperature and pressure. When considering the toxicity of gases and vapors, the solubility of the substance is a key factor. Highly soluble materials like ammonia irritate the upper respiratory tract. On the other hand, relatively insoluble materials like nitrogen dioxide penetrate deep into the lung. Fat soluble materials, like pesticides, tend to have longer residence times in the body**.**

4.0 APPLICABILITY

These policies and procedures are applicable to all ASU employees, students, and affiliated workers.

5.0 REGULATIONS

Carcinogens, U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, U.S. Government Printing Office, Washington, D.C., latest edition.

Documentation of the Threshold Limit Values for Substances in the Workroom Air and Supplemental Documentation, American Conference of Governmental Industrial Hygienist: Cincinnati, OH., (latest edition).

Fire Protection Guide on Hazardous Materials, 7th ed., National Fire Protection Association: Boston, MA.

The Hazard Communication Standard - A Guide Book, National Safety Council: Chicago, IL., 60611.

The Industrial Environment-Its Evaluation and Control, U.S. Department of Health, Education and Welfare, Public Health Service, NIOSH, U.S. Printing Office: Washington, DC., Stock Number 017-001-00296-4, 1973.

Industrial Ventilation, American Conference of Governmental Industrial Hygienists, Committee on Industrial Ventilation: Lansing, MI., (latest edition).

Lewis, R. J., Ed. *Registry of Toxic Effects of Chemical Substances*, DHEW (NIOSH), Publ Microfiche issued quarterly.

NIOSH/OSHA Product Guide to Chemical Hazards, DHEW (NIOSH): Sept. 1978, Publ. No. 78-210.

U.S. Occupational Safety Department and Health Administration (OSHA) Blood-borne Pathogens Standard (29 CFR 1910.1030): Covers human blood, other potentially infectious human body fluids or tissues and human cell lines: http://www.osha.gov/SLTC/bloodbornepathogens/index.html.

OSHA Safety and Health Standards (29 CFR 1910), United States Department of Labor, OSHA, Government Printing Office: Washington, D.C., (latest edition).

6.0 GOVERNING PRINCIPLES

6.1 Overview

ASU is committed to providing a safe and healthy work environment and to prevent injury to personnel and loss or damage to property. It is likewise the University's policy to comply with federal, state, and local regulations that govern safe laboratory practices.

These policies and procedures set a minimal standard for the conduct of educational and research laboratory-based programs at ASU. Principal Investigators, laboratory supervisors, and/or instructors are required to prepare laboratory-specific plans that incorporate the practices articulated herein and set an even higher standard of conduct.

6.2 Training

Persons working with hazardous materials must be trained and proficient in specific safety practices and techniques. Individual administrative units, laboratories, or research groups are

expected to integrate the procedures outlined in this document into their own procedures documents.

Know where information resources for hazardous materials can be found. Collect and communicate all the facts and information resources for hazardous materials to appropriate personnel to minimize exposure risk.

Employees should review safety procedures and be trained when:

- They are new to the University or the laboratory;
- Two years have elapsed and refresher courses are required (primary workers);
- One year has elapsed and refresher courses are required (ancillary workers).
- New procedures, processes, or tests are instituted, even if similar to previous practices.
- Changes or substitutes of any ingredients are made in a procedure.
- The volume increases by 200% or more.
- Equipment fails, especially safety equipment.
- Experimental results are unexpected. Review changes to include in expected hazards.
- Odors, illness or other indicators suggest failure of laboratory safeguards. \
- Assessing the potential for spills or hazardous releases and with general spill response procedures. \
- Working with biohazardous materials.
- Working with blood or other body fluids.

Training classes are offered by the (Employee's Department and/or) Environmental Health and Safety Department.

6.3 Accident Investigation

Accidents in laboratories and/or clinics and infections resulting from work with biohazards must be reported promptly to the Environmental Health and Safety Department to take appropriate action and identify their causes. EH&S personnel will conduct an investigation of these accidents. The PI, supervisor and laboratory personnel shall provide the EH &S with all necessary information and support needed to successfully complete the accident investigation.

It is important to investigate any serious, unusual, or extended illness of a biohazard worker; any accident that involves ingestion, inhalation or dermal contact of infectious organisms; or inoculation of infectious agents and/or rDNA molecules through the skin. If a potentially infectious organism or recombinant DNA molecule were to acquire the capacity to infect and cause disease in humans, the first evidence of this potential may be demonstrated as a laboratory-acquired infection. Verification that an infection is associated with such work or research will

provide sufficient warning for re-evaluation of hazards and initiation of additional precautions to protect ASU-Jonesboro laboratory workers and the public.
The investigation for reporting of all accidents associated with infectious agents or rDNA research should establish the circumstances leading to the accident, including a review of techniques, procedures, types, and uses of equipment that may have been involved in the accident. The EH&S shall provide recommendations for preventing similar occurrences.

7.0 RESPONSIBILITIES

The Chancellor of Arkansas State University (ASU) has ultimate responsibility for safety within the institution and relies upon the Office of Environmental Health and Safety and on the University's safety officers to ensure the safe use of lasers, biohazardous materials, chemicals, and radiation technologies on campus.

7.1 Office of Environmental Health and Safety

- Provides training to laboratory supervisory personnel.
- Conducts periodic, unannounced laboratory inspections to assure compliance with federal, state and institutional regulations.
- Enforces compliance with all federal, state, and institutional safety policies, up to and including independent authority to shut down laboratories for violations.
- Provides hazardous waste disposal services.
- Provides hazardous material spill response services. The Emergency Response Team is available on campus during normal business hours and responds to after-hours spill emergencies.
- Review laboratory construction, modification and renovation plans to ensure safe design.
- Conducts (or contracts for at department's expense) fume hood surveys and other tests.
- Monitors exposures upon request and notifies laboratory supervisors when appropriate.
- Conducts laboratory safety evaluations when requested by laboratory supervisors, principal investigators, or department chairs.
- Provides assistance in obtaining SELECTING personal protective equipment.
- Maintains copies of medical consultations and examinations for possible exposures from hazardous chemicals.

7.2 Facilities Management

- Maintain facilities and facility-related safety systems to assure continuous operation of laboratories.
- Provide support to the Office of Environmental Health as needed.

7.3 Deans

- Ensures the safe operation of all laboratories and other sites in the college where chemicals are used or laboratory procedures are conducted.
- Ensures compliance with the policies and procedures contained in this manual and those in any supplementary information developed in the college in response to specific activities or areas of research.
- Enforces lab closures for safety violations.
- Appoints and delegates appropriate enforcement authority, if appropriate, to the College-wide Chemical Hygiene Officer (CHO) and/or authorize individual Department Chairs and Directors to appoint and delegate appropriate enforcement authority to Departmental Chemical Hygiene Officers. The Dean will maintain a current roster of all CHOs and provide the names of these individuals to OEHS.

7.4 Department Chairs and Directors

- Oversees chemical and biological hygiene within departmental laboratories by ensuring that supervisory personnel reporting to them assume their responsibilities for adhering to all safety policies, regulations and procedures.
- Completes and updates annual inventories of hazardous chemicals as required.
- If authorized by the dean, appoint and transfer appropriate enforcement authority to a Departmental Chemical Hygiene Officer (CHO). The Department Chair or Director assumes all of the responsibilities of the CHO when there is not a specified Chemical Hygiene Officer.

7.5 Safety Officers (Chemical, Biohazards, Radiation, Laser)

- Advises the Dean, Department Chair, or Director on matters of safety policies and practices.
- Works with employees to develop and implement the hygiene policies and practices outlined in this manual and those contained in any supplementary information.
- Monitors compliance with policies and procedures for the procurement, safe use, and proper disposal of hazardous materials.
- Investigates and retains records of accidents involving hazardous materials.
- Conducts information and general training sessions.
- Maintains a resource file of references and publications on safety matters.
- Assists laboratory supervisors and Principal Investigators in writing Standard Operating Procedures (SOPs) pertinent to their needs.

- Ensures that action is taken to correct laboratory practices and conditions that may result in the release of hazardous materials.
- Ensures that action is taken to correct laboratory practices and conditions identified as unacceptable on laboratory safety self evaluations and safety inspections.

7.6 Principal Investigators, Faculty, Laboratory Supervisors

- Designs and conducts laboratory processes and operations to assure that employee exposure to risk conforms to the University's policies and procedures;
- Monitors the procurement, safe use, and proper disposal of chemicals.
- Writes Standard Operating Procedures and other information relevant to lab processes in their specific areas as needed.
- Instructs employees/students on the contents and location of policies, procedures, guidelines, and related materials.
- Takes all reasonable precautions to protect the safety and health of laboratory workers, students, and the environment.
- Schedules services for hazardous waste disposal and oversees the handling of hazardous waste pending proper disposal.
- Conducts regular laboratory safety self evaluations.
- Completes and updates annual laboratory chemical inventories in accord with the instructions and schedules provided by the Office of Environmental Health and Safety.
- Posts emergency telephone numbers by all telephones in the area.
- Posts and updates emergency notifications and laboratory signage.
- Maintains and updates (at least annually) a Biological Safety kit/station outside the laboratory that contains a copy of the current *Emergency Notification Signage, Laboratory-Specific Emergency Plan, Immediate Biohazard Emergency Response,* and emergency phone numbers.
- Provides site-specific training on laboratory hazards.
- Informs employees and students of permissible exposure limits for the hazardous chemicals listed on inventories and the signs and symptoms associated with exposures to these chemicals.
- Prepares emergency response plans for releases or spills and trains laboratory workers and others in the building who may be affected.
- Provides site-specific training on laboratory hazards.
- Obtains pre-approval from the Departmental CHO and provides training and documentation for special procedures, activities or operations.
- Determines the required levels of personal protective equipment, fire extinguishers, fume hoods, flammable liquid storage cabinets, biological safety cabinets, eye washes, safety showers, and spill cleanup kits. Assures that all required equipment is available and in working order and that appropriate training for each item has been provided.

- Maintains current copies of Material Safety Data Sheet for all hazardous chemicals in the laboratory.
- Reports to OEHS if there is reason to believe that exposure levels for a hazardous chemical exceed permissible exposure limits and documents the incident.
- Forwards documentation on laboratory accidents and exposures to OEHS.
- Provides for the safety of visitors.

7.7 Employees/Students

An individual who works with potentially hazardous materials and performs laboratory tasks is required to have proper training in the safe handling and disposal of all materials s/he uses. S/he is likewise responsible for complying with all applicable federal, state, and institutional laws, regulations, and procedures and for conducting activities in a manner that will not endanger him-/herself or others. Specific requirements include:

- Carefully reading all labels and Material Storage Data Sheets (MSDS) to assure appropriate use of hazardous materials.
- Using and maintaining personal protective equipment (i.e. lab coats, chemical splash goggles, face shields, respiratory protection, and gloves) as these guidelines mandate.
- Using flammable liquid storage cabinets, acid storage cabinets, biological safety cabinets, fume hoods, and other laboratory safety equipment appropriately.
- Informing supervisors immediately of any laboratory safety equipment that is not available or is not in good working order.
- Informing supervisor of exposure symptoms, accidents, or chemical releases immediately and documenting the incident.
- Refraining from eating, smoking, horseplay, or personal grooming (e.g., applying cosmetics, removing or inserting contact lenses, etc.) in laboratories where hazardous materials are used.
- Attending all applicable training sessions and seeking training as necessary.

8.0 PROCEDURES

8.1 ACCESS

Access to hazardous materials, or the areas in which they are used, shall be limited to ensure the safety of all inhabitants and visitors. Chemical and/or biological materials shall be maintained by securing and locking the laboratory when unattended by authorized personnel and during all off-hours.

8.2 SAFETY PRECAUTIONS

8.2.1 Personal Protection

Engineering controls to reduce or eliminate exposure to hazardous chemicals may include: substitution of less hazardous substances, substitution of less hazardous equipment or processes, isolation of operators or processes, provision of local and general ventilation (e.g. use of fume hoods) that has been adapted to the worksite, provision of hazard training, and opportunities for job rotation,. Use of personal protective devices are to be used when engineering and administrative controls cannot be used, are not adequate, or while controls are being instituted.

First, determine what chemicals are to be used and what contaminants may be present (e.g., dirt, grease, toxic dust, asbestos, lab chemicals, and bacteriological agents), then contact your supervisor or personnel in EHS (2862) to select the protective clothing that is most appropriate. Keep in mind that Threshold Limit Values (TLVs) and Permissible Exposure Limits (PELs) are based on the inhalation route of exposure. They are normally expressed in terms of either parts per million (ppm) or milligrams per cubic meter (mg/m3) concentration in air. If a significant route of exposure for a substance is through skin contact, the MSDS will contain a "skin" notation. Examples include pesticides, carbon disulfide, carbon tetrachloride, dioxane, mercury, thallium compounds, xylene, hydrogen cyanide.

At minimum, laboratory personnel are required to wear laboratory coats or aprons. If shorts or skirts are worn, lab coats must be knee-length or longer. Closed-toe shoes are required and long hair must be confined. Nylons or pantyhose are not recommended because they may melt upon contact with acid or heat source. Hands and arms must be covered when using lasers or UV light sources.

Protective garments are not equally effective for every hazardous material. Some will penetrate a garment in a very short time. Garment selection thus is based on the specific chemical utilized. Consult the MSDS to ensure appropriate selection of protective garments. If in doubt, contact your supervisor or EHS (2862).

In some cases, additional protective equipment may be required including, but not limited to:

- Eye Protection. All personnel including students, staff, and visitors must wear approved safety glasses or goggles at all times when eye hazards are a possibility. Goggles are also recommended when hazardous splashes or releases are possible. Proper UV-shielded safety glasses must be used with UV light sources. Contact lenses may be worn in the

laboratory; however, they do not provide any protection for the eyes. Persons who wear contacts must use the same eye protective equipment as those who do not wear contacts.

- Face Shields. Full-face shields must be worn when conducting a procedure, which may result in a violent reaction, spray or splash. Full-face shields with bottom caps to protect the neck are preferred as they provide the best protection.
- Respirators. Respirators are designed to protect against specific types of substances and in certain concentration ranges. Respirator selection is based on the hazard and the protection factors required and may only be used after the employee has been trained to use the equipment properly.
- Gloves. Gloves are essential when working with hazardous materials. The proper gloves will prevent skin absorption, contamination, infection, and burns. Consult a glove manufacturer or contact the BSO or personnel within the Environmental Health and Safety Department at 972-2862 for assistance in appropriate glove selection. General selection criteria are as follows:

Glove Table

	Vinyl		**Rubber**		**Synthetic**	**Natural**
Chemical	**Neoprene**	**Plastic**	**Latex**	**Nitrile**	**Latex**	**Latex**
Acrylonitrile	**E**	**G**	**E**	**S**	**E**	**E**
Alcohols	**E**	**E**	**G**	**E**	**E**	**G**
Carbon Disulfide	**NR**	**F**	**G**	**F**	**NR**	**G**
Caustics	**E**	**E**	**E**	**E**	**E**	**E**
Chlorinated Solvents	**G**	**G**	**NR**	**E**	**G**	**NR**
Non-Cl Solvents	**G**	**F**	**NR**	**G**	**G**	**NR**
Formaldehyde	**E**	**E**	**E**	**S**	**S**	**E**
Hydraulic Fluid	**E**	**E**	**F**	**S**	**E**	**F**
Inks	**E**	**E**	**F**	**S**	**E**	**F**
Inorganic Acids	**E**	**E**	**E**	**E**	**E**	**E**
Insecticides	**E**	**E**	**F**	**S**	**E**	**F**
Ketones	**G**	**NR**	**G**	**G**	**G**	**G**
Organic Acids	**E**	**E**	**E**	**E**	**E**	**E**
Paint Remover	**F**	**F**	**NR**	**E**	**F**	**NR**
Petroleum Solvents	**E**	**G**	**F**	**S**	**E**	**F**

Key: S - Superior E - Excellent G - Good F - Fair NR – Not Recommended

Remove contaminated clothing and gloves prior to leaving lab. Hands should be washed frequently, even after wearing gloves, and scrubbed vigorously with soap and water for a full 30 seconds.

8.2.2 Working Alone/Unattended Experiments.

Employees should never work alone in a laboratory when using hazardous materials and should avoid unattended experiments.

8.2.3 Emergency Equipment

Employees should assure that safety showers, emergency eyewash units, fire extinguishers and other safety equipment are functioning and reachable within 10 seconds. Employees should likewise know the locations and proper use of all safety and spill equipment in the area and locate all exits and phones.

8.2.4 Warning Signs and Labels

Biohazards. Post biohazard signs to assure only authorized personnel who have been informed of potential risks enter restricted areas; e.g., Caution –Biohazards, Caution – Hazard, Caution – Radioactive Material, Caution – Radiation Area, Caution - X-Ray, and Caution – Laser. Additionally:

- Post names and phone numbers of responsible personnel on the door(s) where hazardous materials are stored or utilized and prohibit students, faculty, staff and administrators from entering a restricted area, except when accompanied by an authorized user of the facility.
- Label all malfunctioning lab equipment (e.g., fume hoods) to prevent use.
- Affix red or orange biohazard labels on containers, biological safety cabinets, and storage units, refrigerators, freezers, incubators, waste containers, and other equipment that are used for biohazardous materials. Affix human biohazard signs (red) on doors to rooms where microorganisms or biological toxins known to cause disease in humans are used, such as microorganisms classified to be used in Biological Safety Level 2 research activities.
- Affix animal biohazard signs (yellow) where strict animal pathogens are used.
- Affix plant biohazard signs (green) where strict plant pathogens are used.
- Label all chemicals as follows:
- Label all biohazardous agents and materials as follows:
    - Content (Name of Biohazardous Material) and Volume
    - Origin (human, animal or plant source and rDNA information if applicable)
    - Concentration (# organisms/volume, #viable colonies/volume, etc.)
    - Dates (received, prepared, placed in service)

- "Caution Required" and Biohazard Symbol
- Type of Hazards (i.e. inhalation, skin contact, etc.)
- Precautions and Controls (i.e. avoid skin contact)
- Accident Instructions (i.e. wash immediately, etc.)

- Affix "Do Not Touch" labels to waste containers, research equipment, and other hazardous materials including, but not limited to fume hoods, biological safety cabinets, sinks, equipment, or chemicals. Support personnel must contact an authorized user of the facility or EHS (2862) before entering a restricted area.
- Affix labels on UV lamps that state: "CAUTION Ultraviolet Radiation - Protect Eyes and Skin."
- Affix a sign to the UV lamp room stating, "CAUTION Ultraviolet Radiation - DO NOT ENTER AREA WHILE UV LAMP IS OPERATING."

8.2.5 Safe Use of Equipment

Overview. Utilize appropriate safety equipment that is in good condition and design the facility for the appropriate Biological Safety Level. Primary containment safety equipment (e.g., biological safety cabinets) is designed to reduce or eliminate exposure to hazardous materials. Secondary containment is intended to contain hazardous materials in the laboratory to avoid harm to the public or the environment.

Biological Safety Cabinets. Biological Safety Cabinets are primary containment devices that protect the personnel, immediate laboratory, and research and teaching environment from exposure to biohazardous materials. The BSO or personnel in the Environmental Health and Safety Department (972-2862) must be contacted before the use of any new or relocated Biological Safety Cabinet to schedule certification. Open flames, such as Bunsen burners, should never be used in biological safety cabinets as the flame may disrupt airflow, compromising protection of both the worker and the work. Additionally, open flames are extremely dangerous around flammable materials, such (e.g., as ethanol), which is often found in a BSC. Electric incinerators or disposable inoculating loops can be used instead.

Classes of Cabinets. Biological Safety Cabinets have been divided into three classes (Class I, II, and III) based on primary containment capability, design, and cleanliness. Class I and II cabinets are partial containment devices with an air barrier between the operator and biohazard work area. Class III cabinets are "absolute" containment devices with a physical barrier between the operator and biohazard work area.

Laminar Flow "Clean Benches" are not primary or secondary containment devices. They provide the horizontal or vertical positive pressure flow air environment for product protection only. The horizontal flow clean benches are used in clinical, pharmaceutical, and laboratory facilities without toxic, infectious, radioactive, or sensitizing materials.

The vertical flow clean benches are useful for certain manipulations of clean materials (e.g. pouring agar plates, etc.) but must not be used for personal protection.

Inspections. Biological Safety Cabinets must be inspected and certified annually if used for primary containment and personal protection with biohazards. Biological Safety Cabinets must be certified when moved or repaired. It is also recommended that all Laminar Flow "Clean Benches" be certified annually to assure product protection capability.

Annual certifications cover, but are not limited to, the following inspection areas: Down Flow Velocity and Volume; Inflow Velocity (Face Velocity); Airflow Smoke Test; HEPA Filter Leak Test; Electrical Leakage; Ground Circuit Resistance and Polarity; Lighting Intensity; Cabinet Leak Test; Vibration, and Noise Level; and Record of Field Certification. After successful inspection completion, certification labels should be placed on the Biological Safety Cabinet or Laminar Flow Clean Benches.

Safety Procedures. Safety procedures for the use of Biological Safety Cabinets include the following.

- The researcher should wear a closed-front lab coat (or surgical gown) and gloves.
- Gloves should overlap the lab coat or surgical gown cuffs.
- All handling materials should be placed in the cabinet before initiating biohazard work, to minimize in-and-out motions.
- Do not cover or obstruct the air intake grill.
- All biohazard work should be at least four inches in front of the cabinet's front grill.
- When a biological safety cabinet is in use, the lab entry door must be kept closed and traffic minimized.
- Do not use electric fans in the room when the biological safety cabinet is operating this will seriously affect airflow.
- Develop unwanted materials collection and decontamination procedures to avoid clutter and minimize in-and-out motions
- Decontaminate the cabinet with an appropriate disinfectant at the end of each operation.

Autoclaves. To avoid injury or illness, it is critical that all personnel who make use of autoclaves review the operational and safety instructions found in the manufacturer's operating document and participate in training if necessary. Autoclave training is provided by the Environmental Health and Safety Department upon request. This training will focuses on proper autoclave operating procedures, safety practices, maintenance, and testing.

Important Safety Practices. The safe use of autoclaves includes the following practices.

- Load the autoclave properly per the manufacturer recommendations
- Be sure to clean the drain strainer before loading the autoclave
- Before loading containers of liquids into the autoclave, the caps must be loosened to avoid having the bottles shatter during pressurization.
- Use a tray with a solid bottom and walls to contain bottles and catch spills.
- Add ¼ to ½ inch water so the bottles will heat evenly.
- Don't load plastic materials that are not compatible with the autoclave.
- Individual glassware pieces should be within a heat resistant plastic tray on a shelf or rack and never placed directly on the autoclave bottom or floor.
- Make sure the door of the autoclave is fully closed and the correct cycle has been selected before starting.
- Wear heat resistant gloves when cracking the autoclave door open after a run
- Before removing autoclaved items, wait 5 minutes for load containing only dry glassware and 10 minutes for autoclaved liquid loads.
- When removing items from the autoclave, wear a rubber apron, rubber sleeve protectors, heat resistant mitts and a face shield. Remove the load and let the glassware cool for 15 minutes before touching it with ungloved hands.
- Be alert for autoclaved liquid bottles, which are still bubbling. Let liquid loads stand in an out-of-the-way place for a full hour before touching with ungloved hands. Hot glassware and scalding liquids will cause burns and serious harm.

Testing Autoclaves for Effectiveness. Autoclaves should be tested as follows to assure their operational effectiveness.

- **New Autoclaves.** Before putting new autoclaves into service a test load approximating the weight and density of the type of waste generated shall be autoclaved with test spore vials. The spore vials should be placed at the bottom, top, front, rear and center of the autoclave chamber. This can be achieved by either placing vials at those positions within one large test load, or making several smaller test packs with one vial at the center of each and placing the packs at those locations within the chamber.

- **In-Service Autoclaves.** Autoclaves that are used for inactivated human or non-human primate blood, tissues, clinical samples or human pathogens should be tested every 40 hours of run time or monthly, whichever comes first. Autoclaves that are used to inactivate non-pathogenic materials must be tested every six months, at minimum.

  The most common method of testing is using commercially-available test indicator kits with spore strips (usually Bacillus stearothermophilus). The spore strips are placed in the coter of a typical load and run through a sterilization cycle. The spore strips are incubated with the non-autoclaved strips. To remove the spore strips from the biohazard bag without exposure to the contents, place the fresh spore strips inside a glass screw cap tube. Tie a strip around the neck of the tube. Bury the tube in the center of the load as you build it. Thread the string out of the top of the bag before you tie it with autoclave tape. After the kill cycle is completed, open the bag and pull on the string to retrieve the spore strip for incubation. If growth is noted on the autoclaved spore strips, try increasing the run time. If growth still occurs with run times of 45 minute or more, the autoclave may need maintenance and repair.

Recordkeeping. The following records of autoclave-use must be maintained:

1. On-site maintenance records,

2. Autoclave use log per load, containing the following information:

   - Date, time and operator's name
   - Type and approximate amount of waste
   - Confirmation of sterilization by recording the temperature, pressure, and length of time the load is sterilized. Please note that temperature-sensitive autoclave tape is not sufficient.

Autoclave Operating Procedures. A written sterilization procedure must be in place for each workplace. This shall include the following:

Parameters. Appropriate parameters for sterilization shall be determined from the testing with spore vials. The time it takes to sterilize a load will change, depending upon the load density and the sterilization cycle one chooses. Therefore, tests should be performed which imitate these various situations.

- Identification of standard treatment containers and proper load placement shall be made.

- The autoclave and work areas shall be cleaned after every use and the work area shall be disinfected as needed.

Blending, Grinding, Sonicating, Lyophilizing. Blenders, grinders, sonicators, lyophilizers, etc. should be operated in a biological safety cabinet whenever possible. Safety blenders should be used to the extent possible as they are designed to prevent leakage from the bottom of the jar, withstand sterilization by autoclaving, and provide a cooling jacket to avoid biological inactivation. Non-glass containers are preferable to glass but if a glass jar must be used, it must be covered with a polypropylene jar to contain the glass in case of breakage. A towel moistened with disinfectant must be placed over the top of the blender while operating. This practice can be adapted to grinders and sonicators as well. Aerosols must be allowed to settle for five minutes before opening the blender jar (or grinder or sonicator container). Lyophilizer vacuum pump exhaust should be filtered through HEPA filters or vented into a biological safety cabinet. Polypropylene tubes should be used in place of glass ampoules for storing biohazardous material in liquid nitrogen. Ampoules can explode, causing eye injuries and exposure to the biohazardous material.

Compressed Gas Cylinders. When cylinders are received:

- Carefully read the label before using or storing compressed gas. The MSDS will provide any special information. :
- Check to determine whether the name of the gas is clearly labeled.
- Check to determine whether the appropriate hazard warnings are clearly labeled.
- Check to determine whether the hydrostatic test date is within the last 5 years.
- Check to determine that the valve cap is in place and can be easily removed.

When using cylinders:

- Always wear safety glasses when handling compressed gases.
- Always use the minimum sized cylinder required to perform the work;
- Handle cylinders of compressed gasses as high energy sources.
- Always use the correct regulator. Do not use a regulator adaptor. Rather, use a two-stage regulator made for that gas.
- Do not alter, adapt or use Teflon tape on regulator.
- Leak test fittings, piping and connections before work begins.
- The spindle key should remain on the stem while the cylinder is in service.
- Mark cylinders “MT” or “EMPTY”; store separately from full cylinders.
- Use suitable racks, straps, chains, or stands to support cylinders.
- Use an appropriate cart to move cylinders.
- Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out.

- DO NOT lubricate an oxygen regulator or use a fuel gas regulator on an oxygen cylinder. Oil or grease on the high pressure side of an oxygen cylinder can cause an explosion.
- Regulators are gas specific and not necessarily interchangeable (make sure they valve and regulator are always compatible).
- To minimize undesirable connections, use Compressed Gas Association (CGA) pressure regulators and needle valves only.

When cylinders are stored:

- Strap or secure them individually.
- Keep valve caps in place when not in use.
- Keep valves closed when not in use.
- Store cylinders with other compatible gases.
- Do not store flammable gases near oxidizers.
- Flammable gases such as hydrogen or acetylene must not be stored in close proximity to open flames, areas where electrical sparks are generated, or where other sources of ignition may be present.
- Cylinders containing acetylene must never be stored on their sides.
- An open flame shall never be used to detect leaks of flammable gases. Hydrogen flame is invisible, so "feel" for heat.
- Oxygen cylinders, full or empty, shall not be stored in the same vicinity as flammable gases Secure the cap in place to protect the stem when storing or moving a cylinder;
- Do not expose cylinders to temperature extremes.
- Leave 25 psi in cylinder; do not empty cylinder completely. Cylinders should be placed with the valve accessible at all times.
- The main valve should be closed when it is not in use.
- Store cylinders of toxic, flammable or reactive gases in a fume hood or with local ventilation.

Centrifuges. All centrifuges will be used, cared for and maintained in a safe manner. Read the operating instructions for each rotor used and be familiar with the features of the equipment. Safety procedures include the following.

- Rooms where potentially hazardous biological, radioactive materials, toxic or other hazardous chemicals are centrifuged must be identified using the appropriate warning signs.
- Lids shall be closed at all times during operation.
- Operators shall not leave the centrifuge until full operating speed is attained and the machine appears to be running safely without vibration.

- If vibration occurs, the centrifuge should be stopped immediately and load balances checked. Swing-out buckets should be checked for clearance and support.
- The failure rate for used tubes is a hazard so plastic centrifuge tubes should be discarded after one cycle of ultra-centrifugation (high G-centrifugation).
- Nitrocellulose tubes should be used only when transparent and flexible (fresh). They must never be heated because of explosive possibility.
- Leaks can be prevented by not overfilling centrifuge tubes. The outside of the tubes should be wiped with disinfectant after they are filled and sealed.
- Rotors and centrifuge tubes should be opened inside a biological safety cabinet. If a biological safety cabinet is not available, a minimum of 10 minutes settling time should be allowed before opening.
- Rotors and cups should be cleaned and disinfected after each use with non-corrosive cleaning solutions (mild-detergent and distilled water are recommended). Test tube brushes must not be used for cleaning the cup cavities. All traces of detergents should be removed prior to air drying.

Fume Hoods. Safety procedures include the following.

- Ensuring that your work area is clean and uncluttered.
- Verifying that the fume hood has been inspected within the last year.
- Keeping the sash closed at all times when not in use.
- Ensuring that the fume hood is working properly before using it by:
    - Ensuring that its average face velocity is between 100-150 feet per minute.
    - Verifying adequate inward airflow by using smoke tubes or tissue paper if it is not equipped with an air measuring device.
    - Inspecting the bypass area, airfoil, sash, and access opening to verify that air passages are not blocked.
- Ensuring its proper use by:
    - Never using electrical extension cords inside the hood because of the risk of explosion or fire.
    - Keeping the fume hood exhaust on at all times.
    - Elevating large equipment on solid blocks to maintain an airflow space of 1-2 inches above the work surface.
    - Ensuring that the equipment does not block the baffles at the rear of the hood.
    - Keeping all apparatus at least 6 inches inside the fume hood by marking a safety line with tape.
    - Avoiding opening and closing the sash rapidly, and avoiding swift arm and body movements in front of or inside the hood. These actions may increase turbulence and reduce the effectiveness of the fume hood.

    - Positioning the sash so that it acts as a shield. Keep the sash as low as possible. The inspection sticker will indicate the maximum height. Always look through the sash, not under it, and never put your head inside of the hood.
    - Keeping chemical containers tightly closed at all times and checking fittings on laboratory glassware to minimize vapor losses.
    - Using the smallest amount of chemicals for the job, and never using the fume hood to store chemicals and equipment between procedures.
    - Using condensers, traps, or scrubbers to contain and collect waste, solvents, vapors, or dusts.
    - Cleaning all spills immediately and not allowing spilled liquid chemicals to evaporate.
    - Substituting less hazardous or (at least) less volatile chemicals where possible.
    - Considering process changes that not only improve safety, but reduce losses to the environment (e.g., more accurate chemical delivery systems vs. pouring volatile chemicals from bottles).
    - Consider capture devices such as condensers even when working in the hood to reduce emissions and possibly to salvage product for reuse.
- Emergency procedures include:
    - Closing the sash if a fire occurs inside the fume hood, activating the fire alarm, exiting the room, closing the door and calling 9-911 from a safe area.
    - If equipment in use is defective or overheating, shut it off, disconnect, close the sash, and report the problem to the supervisor.

Respirators. Particle-removing air purifying respirators, gas and vapor-removing air purifying respirators, or atmosphere-supplying respirators may be required in some cases. If required, employees must comply with the University Respiratory Protection Program, which includes an initial medical assessment, annual fit testing and instructions on proper use.

Fire Extinguishers. Fire extinguishers appropriate for laboratory use must be available, charged, and mounted in a location that is immediately accessible (within 75 feet or as required by the Environmental Health and Safety Department and the Arkansas Fire Code). There shall be no obstructions that might inhibit the use of this equipment.

Freezers and Refrigerators. Freezers and refrigerators should be checked and cleaned out periodically to remove any broken ampules, tubes, etc. containing toxic or infectious material. Use rubber gloves during this cleaning. Label all biohazardous or toxic material stored in refrigerators or deep freezers (refer to Section 4.3.8). Discard old specimens or samples when no longer needed. Laboratory freezers and refrigerators should not be used for the storage of food products for human consumption.

Sharps and Laboratory Glass

Sharps. The term "sharps" is a regulatory waste classification associated with those instruments used to puncture, cut or scrape body parts and that as waste, can cause punctures or cuts to solid waste handlers or the public. Sharps" are a restricted waste and must not be disposed of in the regular waste stream.

Sharps include the following:

- Hypodermic needles
- Syringes (plastic, glass or metal) still connected to the needle
- Sharp or broken glass contaminated with biohazardous materials
- IV tubing with needles attached & suture needles
- Lancets
- Scalpel blades
- Glass Pasteur pipettes
- Microtome blades
- Dental scalers
- Razor blades
- "Other" sharp metal laboratory waste

Handling Laboratory Sharps. The best way to prevent cuts and sticks is to minimize contact with sharps and to dispose of them immediately in appropriate disposal containers that are closable, puncture resistant, leak proof on the sides and bottoms. Sharps disposal containers must be easily accessible to laboratory personnel, labeled, and located as close as feasible to the area where sharps are used. Puncture-proof sharps containers are available from Environmental Health and Safety at 972-2862 in 1 quart, 2 gallon, and 8 gallon sizes. Departments are responsible for purchase of containers.

Working with laboratory sharps is a major hazard that needs to be reviewed and included during the risk assessment process to minimize laboratory personnel exposure. Two of the major risks when using sharps are accidental injection and the creation of aerosols. Needles and syringes should only be used when there is no reasonable alternative. Work that may create biohazardous aerosols must be performed in biosafety cabinets whenever possible.

Storage of Laboratory Sharps. The law requires that sharps be segregated by functionality; accessibility; visibility and accommodation. The criteria include closure mechanisms, stability, size, shape, mounting brackets, opening/access mechanism,

handles, placement location, installation height, fill status, labeling, illumination, security, portability, ease of assembly, operation, storage and flexibility of design.

Containers are red in color and equipped with a tight-fitting lid for use during handling and transport. Biohazardous material contaminated sharps must be labeled with an International Biohazard Symbol. Read the authorized sharps container manufacturer's instructions and recommended user training information prior to use.

Disposal of Laboratory Sharps. Laboratory sharps cannot be placed with regular trash; rather, they must be disposed of in authorized puncture-proof and leak-proof containers that indicate the kind(s) of contamination present. Additionally, when discarding sharps:

- Never bend, shear, break, or recap disposable needles or remove from disposable syringes.
- Immediately following use, place the item into the sharps disposal container.
- Never reach into the sharps disposal container.
- Never empty the contents of the sharps disposal container into another container.
- Never remove the lid from the container.
- Never overfill a sharps disposal container; no materials should be sticking out of the top.
- Never force materials into a sharps disposal container

If feasible[1], autoclave the biohazardous material sharps container. Place a piece of autoclave tape over the biohazard symbol on the container prior to autoclaving. The vent holes on the lid should not be covered during the autoclave cycle. After autoclaving, re-label the container as "non-contaminated sharps waste" with the room number and the Principal Investigator's name. All treated and untreated laboratory sharps[2] containers must be labeled with the kind(s) of waste contamination present, sealed appropriately, and placed at the designated collection point for your department. If you do not know the designated collection points for your facility, (delete) contact Environmental Health and Safety (972-2862).

Laboratory Glass

[1] Large plastic buckets used for glass Pasteur pipettes are not autoclavable so they must not be used if biohazardous contamination is a risk.

[2] If the sharps cannot be safely autoclaved or you do not have an autoclave in your laboratory, contact Environmental Health and Safety for assistance.

Uncontaminated and unbroken laboratory glass, plastic items (except for syringes still connected to the needle), plastic pipettes, solvent bottles, light bulbs, paper materials, pipette tips, aerosol cans, cans, scintillation vials that do not contain biohazardous materials, and items that contain liquids (except for blood in vacutainers) are not within the "sharps" classification and are thus not restricted waste. They can be disposed of in the regular waste stream after placement in appropriate packaging to prevent breakage. Uncontaminated broken laboratory glass must be placed into a container labeled "broken glass" (closable, puncture resistant and leak proof) prior to disposal in the regular waste. This process will minimize the potential of punctures or cuts to solid waste handlers or the public.

The following safety tips for laboratory glass should be used to prevent injury.

Glass Tubing. When inserting glass tubing into stoppers, lubricate tubing and wear leather gloves to protect hands from tubing slips and breaks.

Inoculating Loop Sterilization. The greatest risk when sterilizing inoculating loops in an open flame (such as with a Bunsen burner) is the creation of aerosols, which may contain viable microorganisms, and flammable material. A shielded, electric incinerator or hot- bead sterilizer should be used to minimize aerosol production. Disposable plastic loops and needles are good alternatives.

Pipets. The greatest risks with pipetting are splashing and the creation of aerosols. All biohazardous materials should be pipetted in a Biological Safety Cabinet whenever possible. Cotton-plugged pipettes should be used as should mechanical pipetting aids. (Pipetting by mouth is expressly prohibited.)

Biohazardous materials must never be forcibly discharged from pipettes. "To deliver" pipettes should be used instead of pipettes requiring blowout. To avoid splashing, biohazardous material should be dispensed from a pipette by allowing it to run down the receiving container wall. Reusable pipettes should be placed horizontally in a pan filled with enough liquid disinfectant to completely cover them. The entire pan should then be autoclaved before cleaning the pipettes for reuse.

Ultraviolet Light (UV). Appropriate personal protective equipment and shields should always be used when operating fixed or portable UV radiation fluorescent lamps (180-400 nm wavelength) as the light may produce acute adverse effects such as corneal injuries (welder's flash), erythema, photokeratitis, and lens cataracts. Other safety precautions include:

- Locating UV boxes in low-occupancy areas, preferably in separate rooms, alcoves, or behind curtains when inside a larger lab.

- Minimizing contact times.
- Maximizing distance by working at arm's length and avoiding stooping over the work surface.
- Replacing the plastic covers every few years or sooner if discoloration or cracking is observed.
- Obtaining medical attention if over-exposed to UV light.

Lasers. Please see the Governing Principles and Procedures for Laser Safety for detailed information.

Dosimiters. Please see the the Governing Principles and Procedures for Radiation Safety for detailed information.

Hazardous Chemicals. The HMIG label, as below, is where the Health, Flammability, and Reactivity Index Ratings are recorded.

Radiation. The Arkansas Department of Health (ADH) has adopted regulations with standards to protect individuals from hazards associated with radioactive materials that are licensed by the ADH. The ADH requires that the University post a copy of RH-2824 *Notice to Employees, Standards for Protection Against Radiation* in a conspicuous place for all employees working in any portion of a restricted area. See Appendix F for additional information. Consequently, all lab areas that contain radioactive material will be indicated by the posting of the standard trefoil warning sign at the entrance to the laboratory. Address and telephone numbers of the principal user involved with the lab will be clearly indicated thereon. Signs are required by regulation to denote areas or containers with levels of radiation or radioactivity specified in the following sections:

Radiation Areas. Each radiation area shall be conspicuously posted with a sign or sign bearing the radiation symbol and the words "CAUTION RADIATION AREA" in areas accessible to personnel in which the total effective dose received in any one hour exceeds 0.002 rem (0.02 mSv) and 0.05 rem (0.5 mSv) in a year.

High Radiation Areas. Each high radiation area shall be posted with a sign or signs bearing the radiation symbol and words: "CAUTION HIGH RADIATION AREA." In addition, one or more of the following features must be utilized at the entrance or access point to the high radiation area:

- A control device that upon entry causes the level of radiation to be reduced below the level at which an individual might receive a deep-dose equivalent of 0.1 rem (1mSv) in one (1) hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

- A control device that energizes a conspicuous visible or audible alarm signal so that the individual entering the high radiation area and the supervisor of the activity are made aware of the entry; or
- Entryways that are locked, except during periods when access to the area is required, with control over each individual entry.

Very High Radiation Area. Each area in which there may exist radiation levels in excess of 500 rads (5 grays) in one (1) hour at one (1) meter from a radiation source or any surface through which the radiation penetrates must be posted with a sign or signs bearing the radiation symbol and "GRAVE DANGER, VERY HIGH RADIATION AREA". Each entrance or access point must be equipped with entry control devices which function automatically to prevent any individual from inadvertently entering the area when very high radiation levels exist.

Radioactive Materials. Each laboratory or area where radioactive materials are used or stored must be posted at the entrance with a "CAUTION RADIOACTIVE MATERIALS" sign. Entry and area warning signs are to be posted and removed only after notifying the RSO.

Refrigerators, freezers, and other "in lab" storage areas, and containers in which materials are stored or transported must have a visible label with the radiation caution symbol and the words "Caution Radioactive Materials". The label should also state the kind and approximate quantity (e.g. "< 250 Ci) of radioactive material in the container.

Airborne Radioactivity Areas. The Radiation Safety Officer must give approval prior to any research utilizing airborne radioactive materials. Any room, area or enclosure in which airborne radioactive materials exist in concentration excess of the amounts specified in RH 2200, Appendix A, Table 1, Column 1 of the ADH Rules and Regulations.

Equipment. All vessels containing radioactive materials will be clearly marked with radiation warning tape and/or labels stating:

- Radioisotope
- Chemical Form of the Radioisotope
- Total Activity at date of purchase
- Date of Purchase

All glassware used in experiments involving radioisotopes will be labeled with radiation warning tape, with the particular radionuclide(s) inscribed thereon, until the vessel has been decontaminated and checked for radiation.

Material Safety Data Sheets

A Material Safety Data Sheet (MSDS), prepared in accordance with OSHA Hazard Communications Standards, is a document that is prepared by the manufacturer explaining the nature of the hazard and its safe handling. The following is a section by section review.

Section I: Chemical Product and Company Identification

- Links the MSDS to the material.
- Identifies the supplier of the MSDS.
- Identifies a source for more information, including emergency information, if available.

Section II: Composition and Information on Ingredients

- Lists the Occupational Safety & Health Administration hazardous components.
- May also list significant non-hazardous components.
- Lists corresponding Chemical Abstracts Registry Numbers, where appropriate, for each component.
- May include additional information, such as exposure guidelines, about components.

Section III: Hazards Identification

- Provides information on the potential adverse health effects and symptoms that might result from reasonably foreseeable use and misuse of the material.
- May provide an emergency overview that describes the material's appearance and severe, immediate health, physical, and environmental hazards associated with emergency response situations.

Section IV: First-Aid Measures

Provides easily understandable instructions on what to do when results of exposure require immediate treatment and when simple measures may be taken before professional medical assistance is available. Instructions provide for each route of exposure.

Section V: Fire-Fighting Measures

- Provides basic fire-fighting guidance, including appropriate extinguishing media.
- Describes other fire and explosive properties useful for fighting fires involving the material such as flash points, explosive limits.

Section VI: Accidental Release Measures

- Describes actions to be taken to minimize the adverse effects of an accidental spill, leak, or release of the material.

Section VII: Handling and Storage

- Provides information on appropriate practices for safe handling and storage of the material.

Section VIII: Exposure Controls Personal Protection

- Provides information on practices and/or equipment useful for minimizing worker exposure.
- Provides guidance on personal protection equipment.
- May also include exposure guidelines.

Section IX: Physical and Chemical Properties

- Identifies the physical and chemical properties that characterize the material.

Section X: Stability and Reactivity

- Describes the conditions that could result in a potentially hazardous chemical reaction.

Is there any other useful information about this material?

Section XI: Toxicological Information:

- May be used to provide information on toxicity testing of the material and/or its components for medical professionals, occupational safety and health professionals and toxicologists.

Section XII: Ecological Information:

- May be used to provide information on the effects the material may have on plants, animals, and its environmental fate.

Section XIII: Disposal Considerations:

- May provide information useful to determine appropriate disposal measures.

Section XIV: Transportation Information:

- May provide basic shipping classification information.

Section XV: Regulatory information:

- May be used to provide information on state, federal, and international regulations affecting the material or its components.

Section XVI: Other Information.

8.2.6 Clean-up Supplies

- 2 red bags,
- 2 cloth rags,
- 2 clear bags,
- brush,
- roll of clear of tape,
- flashlight,
- barricade warning tape,
- anti-microbial wipes,

- household bleaches or spray disinfectants,
- paper towels,
- absorbent-sock,
- decon pad,
- vermiculite,
- scoop,
- floor drain cover,
- mechanical means for dealing with broken glass,
- forceps,
- dustpan,
- broom,
- sharps container or bucket labeled “Broken Glass” (Metal or thick plastic) to collect and dispose of broken glass.
-

Check all supplies annually for deterioration and replace disinfectants or determine if they are still usable.

8.2,7 Spill Kits

Maintain spill clean-up kits suitable for laboratory spills. Kits are available from EHS or can be prepared by the PI or laboratory supervisor. Each kit should contain:

- MSDS information;
- Emergency Notification Signage for the laboratory
- Laboratory Specific Emergency Plans for the laboratory
- Immediate Biohazard Emergency Response Procedures
- Absorbent material,
- Absorbent pads,
- Acid Neutralizer,
- Base Neutralizer,
- Biohazard-Specific Disinfectant (Bleach),
- Gloves,
- Hazardous waste container (bags),
- Solvent Adsorbent.

(We provide Spill kits for BBP and for Chemicals)

Post the following on the outside of Laboratory Biosafety Spill Kit container:

- Inventory sheet of equipment and materials in the biosafety spill kit.
- Phone contact number for responsible Principal Investigator/Supervisor.

- Phone EHS at 972-2862 to report ALL releases & bloodborne pathogen exposures.

8.2.8 Clean Environments

One of the most important steps to improving safety is to maintain a clean environment. Floors, laboratory benches, equipment, and other surfaces should be disinfected routinely. All biohazardous material waste should be autoclaved, sterilized, or placed in a Biohazard Unwanted Materials container for disposal. Exits, aisles, and safety equipment should not be obstructed. A minimum of 36 inches width must be maintained for laboratory aisles. Hallways are not to be used as storage areas.

8.2.9 Access to Electrical Equipment

Access to electrical equipment (e.g., plugs, switches, and electrical panels) should be maintained at all times. Obstruction should never prevent immediate access in an emergency. Use polarized and grounded receptacle outlets in general laboratory areas and Ground Fault Circuit Interrupters (GFCIs) in wet or outdoor locations. Cords should not run in aisles or corridors, through doors, walls, partitions, under rugs, or above suspended ceilings.

8.2.10 Safe Handling

Carefully read labels and the MSDS prior to using hazardous materials to ascertain the appropriate handling of hazardous materials, and use personal protective equipment that is recommended. Use chemicals only if appropriate exposure controls are in place (e.g., if your fume hood is not working, don't use chemicals you must use only in a fume hood) and equipment and glassware are in good repair. Always use chemicals with proper ventilation as per the MSDS. Use chemicals and equipment only for their intended purposes. Avoid direct contact with chemicals; never smell, inhale or taste them. Do not dispense more chemical than is needed for present use. Electrically ground and bond containers using approved methods before transferring or dispensing a flammable liquid from a large container.

In addition to the general safety guidelines mentioned above, special precautions are required when handling select agents and biological toxins, high consequence livestock pathogens or toxins, and plant pathogens with a high degree of acute toxicity. The Registered User should ensure that precautions designed to minimize risk of exposure to these substances are taken. The following are minimal guidelines:

- Report any newly identified select agents or toxins, high consequence livestock pathogens or toxins and plant pathogens immediately to the Environmental Health and Safety Department.

- Quantities of select agents or toxins should be minimized, as should their concentrations such as in cultures, broths, or lyophilizing these select agents and biological toxins.
- Using work practices that block routes of exposure can prevent workplace infection. Good microbiological techniques must always be used in the laboratory.
- Each laboratory using these substances must designate an area for this purpose, sign or mark this area with an appropriate hazard warning such as a Biohazard Warning Sign. Refer to Appendix L for illustration of the specific Biohazard Warning Signs (Human, Animal and Plant).
- All laboratory workers and ancillary workers in a laboratory with an area designated for use with select agents, biological toxins, and acutely toxic chemicals must be trained in the harmful effects of these substances. This should include recognizing signs and symptoms of exposure. Training to safely handle and store these substances is required for those who use or may potentially be exposed to these materials. This training is the responsibility of the Registered User or Principal Investigator and must be done prior to the use of any of these materials.
- Laboratory workers using these select agents and biological toxins must have access to appropriate personal protective equipment (available at no expense to the worker) and must be trained to properly use this equipment.
- Detection equipment may be required if acutely toxic chemicals are used with biohazardous material.
- All unwanted chemical hazardous materials containing biohazardous material should be collected and disposed of promptly as outlined in Chapter 5. The designated working area must be thoroughly decontaminated and cleaned at regular intervals that are determined by the Principal Investigator. The interval may be as short as every few minutes to as long as one day depending upon the frequency of usage and the level of hazard.
- Special precautions are required to avoid release and exposure of biohazardous materials. For instance, pipetting liquid biohazardous agents should always be conducted in a certified Biological Safety cabinet. Needles should never be recapped due to the high risk of punctures.
- Emergency response planning for biohazardous releases or spills should be prepared by the Principal Investigator and be included in the training of the laboratory workers and others in the building who may be affected. Refer to Chapter 6 for Emergency Response information.

8.2.11 Sterilization, Disinfection, and Decontamination

Overview. No single chemical disinfectant or method will be effective or practical for all decontamination situations. Therefore, consider when selecting chemical disinfectants and procedures, the purpose for decontamination and the interacting factors. The following questions will help in choosing which chemical disinfectant is best: 1) What is the target microorganism?; 2) What disinfectants are known to inactivate the target microorganism(s)?; 3) What degree of inactivation is required?; 4) How is the microorganism suspended (i.e. simple or complex, on solid or porous surfaces, airborne)?; 5) What is the highest concentration of cells anticipated to be encountered?; 6) Can the disinfectant be expected to contact the microorganisms and can effective contact duration be maintained?; 7) Is it compatible with the material to be contaminated?; 8) What is the product stability?; 9) Will there be an absence of residues?; 10) Is the disinfectant nontoxic, non-allergenic, non-carcinogenic, non-irritating, and have no noxious odors? Other considerations include: the number of organisms on the material and their resistance to the sterilizing agent; protection afforded organisms by extraneous matter – direct steam must establish direct contact on all surfaces; the numbers of organism dying per unit of time in proportion to the numbers present at start to time interval; the functional efficiency of the sterilizing method and the reliability of the mechanical components, and human error in operation of equipment.

Agar, proteinaceous nutrients, and cellular materials can be very effective in physically retarding or chemically binding active moieties of chemical disinfectants. These interferences will dictate the use of disinfectant concentrations and contact items in excess of those shown to be effective in the tube test

Types. Sterilization is the process of treating an object or material to remove or kill <u>all</u> living organisms. Disinfection is the process of killing pathogens agents by chemical or physical means directly applied. Disinfection does not mean the destruction or removal of all organisms. Therefore, this may not necessarily create sterile conditions. Decontamination is defined as the reduction of microorganisms to an acceptable level. The process of decontamination can be achieved by either disinfection or sterilization.

Whether or not sterility is achieved depends on several factors: 1) Types and number of microorganisms; 2) Concentration of the agent; 3) Length of contact time with the agent; 4) Presence of organic matter and dirt; 5) Temperature; 6) Condition and nature of the surface(s). Sterilizing and disinfecting agents attach microorganisms in various ways. Some disinfectants will coagulate or denature the protein rendering the cell nonfunctional. They may injure the cell membrane, altering the normal selective permeability, allowing metabolically important components to escape, or prevent the entrance of food. In addition, they may react with a specific enzyme to prevent it from reacting with its natural substrate.

There is a wide range of reaction from microorganism to inactivating agents. Most vegetative bacteria, fungi, and lipid containing viruses are relatively susceptible to chemical decontamination. The non-lipid containing viruses and bacteria with a waxy coat occupy a midrange of resistance. Spore forms are the most resistant.

Sterilization Using Autoclaves. Autoclaving provides heat and moisture as the damage factors to destroy organisms. Most organisms can be destroyed in the presence of steam under pressure at 121°C for a minimum of 15 minutes. The time is measured after the temperature of the material being sterilized reaches 121°C. The major problem to insuring the reliability of this method, other than time and temperature, is the prevention of air entrapment. Air must be replaced by the steam and adequate exposure time as related to the soil load on contaminated items.

Some type of autoclaves have downward or gravity displacement which takes advantage of the difference in air density relative to steam. The displaced air is driven out through the drain line located in the lower front of the chamber. A valve in the drain line remains open until a specific pre-set temperature is reached. When this temperature is reached, the valve closes and steam continues to enter until the pre-set pressure or temperature is achieved. A concern with this type of autoclave is that air trapped in closed or upright containers placed in the chamber, or reduced loads in the chamber are not completely displaced. If the air is not displaced, the temperature will remain to low in that area throughout the sterilization process thereby not being effective. Therefore, autoclaves of this type should not be overloaded; tightly packed and open containers should be turned on their sides.

High vacuum autoclaves draw a vacuum in the chamber prior to entrance of steam. If the vacuum is greater than 27 inches Hg, the air removal concern is alleviated. The principal advantages of the high vacuum sterilizers are their fast cycle time and the fact that a much larger volume of material can be processed per day than with downward displacement. Another advantage is the minimized damage to materials because of the shortened overall exposure to heat. Heavily soiled items, especially if the soil is of a proteinaceous nature, should be autoclaved longer because soil may protect the microorganism from the lethal effects of wet heat.

Other practices that improve the efficacy of autoclaving include removing and cleaning the equipment plug screen or strainer daily to make sure it is free of dirt, dust, or sediment, and cleaning the interior surfaces of residue collected from the steam or materials being sterilized. Spore strips or other satisfactory performance testing materials can be placed a various locations within the autoclave as indicators of sterility.

NOTE: Autoclave tape does not assure sterility; the tape indicates only that the proper temperature has been achieved and is not dependent on time.

Dry Heat. Dry heat is used for the sterilization of anhydrous oils, greases, powders, etc., that cannot be easily permeated by steam. Dry heat is less efficient than wet-heat sterilization and requires longer times or higher temperatures; specific time and temperature must be determined for each type of material being sterilized.

Sterilization can usually be accomplished at 160-170°C for periods of 2-4 hours. Higher temperatures and shorter times may be used for heat resistant materials. The heat transfer properties and arrangement of articles in the load are critical to insuring effective sterilization.

Gas Sterilization. A variety of gases and vapors possess germicidal properties. The most useful are formaldehyde and ethylene oxide. Sterilization can be achieved when these are employed in closed systems and under controlled conditions of temperature and humidity.

Ethylene oxide gas is lethal for microorganisms including spores, viruses, fungi, and highly resistant thermophilic bacteria. The effects of time, temperature, concentration, and humidity upon the rate of sterilization of ethylene oxide are directly related. Doubling the concentration will achieve sterilization in about half the time. The effect of temperature is that with each 10°C temperature increase, the sterilization activity is doubled. At a relative humidity (RH) of 30%, sterilization is most rapid, becoming progressively slower as the relative humidity increases to 100%.

All materials sterilized with ethylene oxide must be aerated at least 24 hours before contact with the skin. Mixtures of 3-10% ethylene oxide in air are explosive. Commercially available mixtures of ethylene oxide in Freon or CO^2 are not explosive and can be used safely.

Steam Sterilization. The advantage of using steam sterilization is that most resistant bacterial spores are eradicated with relatively brief exposure. Other advantages include:

- Easy control of lethality for various materials and supplies.
- No toxic residue and materials following sterilization process.
- Most economical method.

The disadvantages associated with the technique include:

- Incomplete air elimination from sterilizer depresses temperature and prevents sterilization. Air is a stubborn opponent to the diffusion and expansion of steam.

- Possible superheated steam with diminished microbial power if sterilizer is used incorrectly.
- Unsuitable method for sterilization of anhydrous oils, greases, and powders.

Chemical Disinfectants. Chemical disinfectants are effective alternatives since steam sterilization is not feasible for use in large spaces, surfaces, and stationary equipment; high temperatures and moisture also may damage delicate instruments. There are many trade names for the wide variety of disinfectants. Basically, the chemical disinfectants fall into the following categories: acids/alkalis, alcohols, chlorides, formaldehyde, gluteral-dehyde, iodine, mercurical, phenolics, and quaternaries.

The relative resistance to chemical disinfectants can be substantially altered by such factors as: 1) Contact time; 2) Human error; 3) Concentration; 4) Presence of organic matter and dirt; 5) Temperature; 6) Humidity; 7) Types and numbers of microorganisms; 8) Condition and nature of the surfaces. The degree of success achieved with chemical decontaminants may range from minimal inactivation of the target

Monitoring Sterilization. All sterilizers should have time-temperature recorders to provide evidence of adequate exposure for each load. Evidence that a sterilizing temperature has been held for an adequate time, however, does not insure sterilization. This is because the temperature is measured at the outlet valve. Therefore, it does not indicate whether adequate sterilization occurred within dense volumes of liquid or large, dense, fabric-wrapped packs. Residual air or super heating may also result in incomplete sterilization. The use of chemical monitors, i.e. test-tapes, within the autoclave provides only an indication that a sterilizing temperature may have been reached. However, such monitors do not show whether there was adequate exposure. The best means of insuring sterility is to use a biologic spore monitor.

Microorganisms chosen for spore strips are more resistant to sterilization than are most naturally occurring contaminants. The test organisms are in high concentrations to insure a margin of safety. The spores will be in either impregnated filter-paper strips or in solution in glass ampoules. For steam and hot-air sterilization, the thermophile, *Bacillus sterathermophilus*, is used. *Bacillus globigii* is used for ethylene oxide.

Most spore strip preparations are provided in envelopes that contain one or two strips and a control strip. The test strips are packaged in separate envelopes that are removed and sterilized at the time other material is processed. Subsequently, the test strips and control strips are cultured by placing the strips in a tube of tryptic-digest, casein-soy broth. These are incubated at 37°C for gas sterilization and 56°C for steam sterilization. Other types of spore preparations are commercially available. The manufacturer's directions should be followed closely.

Steam and hot air sterilizers should be tested once a week. Every load of material sterilized with ethylene oxide that is to be placed in contact with deep tissues should be tested. Place the test strips in the center of the test specimen. Never place the strips on an open shelf in the autoclave. Place an ampoule containing a spore solution in the largest vessel to test fluid sterilization.

Handling the spore strips in the laboratory requires considerable care to prevent secondary contamination. Make the transfer with sterile forceps and scissors. Take care not to cross-contaminate the sterilized spore strips with the control strip.

Perform gram staining and sub culturing to prevent false-positive reports that could result from secondary contamination of these cultures.

Whenever positive results are obtained, retest the sterilizers immediately with careful examination of thermometer and pressure gauge readings as well as review of recent time and temperature records. If any deficiency is observed, or if the repeated sterility test still results in growth, engineering personnel should be consulted promptly.

8.3 PROCEDURES FOR SPILLS OR RELEASES

8.3.1 Biohazardous Materials

Team Response. The PI, supervisor, and biohazard workers shall form a team to respond to emergency events. Decontamination team members must receive appropriate training and assure that the equipment, and supplies needed to handle emergency releases are readily available.

General Disinfection/Decontamination Procedures.

The following are general guidelines for disinfection or decontamination:

- Before re-entering the affected area, wait a minimum of 30 minutes to permit reduction of airborne particles by ventilation changes. Verify the biological safety cabinet is operational.
- Review available protective equipment/materials, biological safety kit/station, and personnel resources. Develop and communicate response and decontamination clean-up plans.
- Use appropriate disinfecting solution[3] (example: 1 part household bleach (5.25% sodium hypochlorite) and 9 parts water) to treat the spill area. To minimize aerosols, do not spray

[3] After selection of a chemical disinfectant that is effective against the microbes or agent being investigated, the PI or supervisor must schedule ongoing procurement of bulk concentrate and working disinfectant supply. One way to assure a continuous supply is to maintain two sources

the disinfectant. Pour it gently, directing its flow into the spill area. Cover the area with absorbent paper or cloth. Allow 20 minutes of contact time.

- Use an autoclavable (or expendable) dustpan and squeegee and transfer all materials from the spill area to a deep autoclave pan including, finally, the dustpan and squeegee. Cover the pan with foil or other means for transfer to an autoclave. Remove the rubber gloves worn to that point, leave in the autoclave and don a fresh pair.
- Wash and mop the spill area and adjacent areas with disinfecting-detergent solution.
- Before leaving the immediate area, wash rubber boots with disinfectant solution, remove and bag respirator(s) (separately) and then remove cap, gown, and rubber gloves for appropriate disinfection or autoclaving. The boots should be exchanged for conventional disposable booties before leaving the area.
- The Supervisor shall be responsible for ensuring that all unwanted materials, equipment, and clothing are properly disinfected and accounted for. Replenish biological safety kit/station and used resources (gloves, garments, disinfectants, etc.) for future use.

The University Safety Coordinator, with assistance from the PI or laboratory supervisor, will make the determination that an area is safe for reentry after a biohazard incident. Others are not to enter or reenter the area without EHS' consent for any reason until the area is released. EHS, if appropriate, will allow authorized individuals to re-enter and monitor, control, investigate, remove, rebuild, reinforce, and perform temporary fixes for the facility as necessary before others have access to the area.

Releases/Spills in Biological Safety Cabinets.

The function of biological safety cabinets is not only to provide a work area free from background contaminants, but also to contain any release of microorganisms or other infectious material. Potential contamination from routine procedures is normally dealt with following completion of an experimental procedure or at the conclusion of a work session. A biological spill occurring in the biological safety cabinet should be disinfected immediately and the cabinet airflow maintained. At all times there should be a supply of effective disinfectant within the cabinet so the operator does not have to withdraw his/her arms before proceeding with decontamination. If the operator's hands and arms have come into direct contact with the

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of disinfecting solution, i.e., one for immediate use and the other reserved for emergency use (see biological safety spill kit/station). As the immediate-use supply is depleted, the emergency-use lot replaces it and a freshly prepared solution becomes the emergency-use supply. In small laboratories, effective shelf life of a disinfectant may be exceeded before the working supply is exhausted. Additionally, supervisors must devise schedules for disposal of ineffective residual disinfectants. Economics must not take precedence over assuring adequate quantities of disinfectants are available to cope with any spills.

biological material, disinfectant should be liberally applied to them. (NOTE: Plastic over-sleeves prevent absorption of spilled materials by porous garments). The area of the spill should be gently flooded with disinfectant sufficient to cover the top tray, drain pans and catch basin below the work surface. While waiting for the twenty minutes to elapse, the walls, any work surface, equipment, and recoverable supplies not previously treated should be wiped down with a cloth or sponge saturated with disinfectant. Excess disinfectant from the tray and drain pans should be dumped into the cabinet base. Lift out the removable bench tray and perforated front grille. Wipe down all surfaces with disinfectant and replace in position. Place all used cleaning materials in a suitable container and autoclave or treat with a strong hypochlorite solution or appropriate disinfectant for the agent(s). Drain liquid disinfectant from cabinet base into appropriate container(s) and autoclave according to standard procedures. If sodium hypochlorite or an iodophor disinfectant was used, add sufficient thiosulfate to inactivate the oxidant immediately before autoclaving.

If the instruments or equipment contained in the Biological Safety cabinet is not compatible with a liquid disinfectant, problems in assuring penetration by the liquid disinfectant will require procedure modifications. The bulk of the spilled material should be gently flooded with disinfectant as before. Salvageable biological materials in intact containers should be surface disinfected and placed in a covered container. The secondary container is surface disinfected and removed to another Biological Safety cabinet to continue the experiment or to ready the materials for appropriate storage, pending continuation of the experiment. The contaminated safety cabinet is then disinfected by the paraformaldehyde gas procedure (requires Biological Safety Professional approval). Alternatively, small instruments may be placed in plastic bags, the bags sealed, surface disinfected, and removed to an autoclave equipped for dry instrument sterilization. Wet chemical decontamination can then proceed as before.

Spills occurring in total containment cabinets need not be as disruptive for work schedules. Spills in these can usually be flooded with a liquid disinfectant, wiped up (taking care not to cut or otherwise damage gloves with broken glass or other sharp materials present), and cleaning materials placed in a covered container of liquid disinfectant. Remaining materials can be surface disinfected with adherence to aseptic techniques, and then the experiment can continue. Total decontamination of the cabinet may thus be delayed until the end of the work session.

If airflow in a biological safety cabinet changes abruptly or the power fails more than momentarily while working with BSL-2 agents the following procedures are recommended:

- Terminate work with the agent, taking care not to create aerosols.
- Leave the laboratory and assure that others have also left.
- Secure the laboratory from entry by other personnel.
- If the agent poses a health hazard to humans, contact the Environmental Health and Safety Department (972-2862) or University Police Department (972-2093).

- When power is restored wait 30 minutes to reduce airborne particles, verify the operation of the biological safety cabinet, then disinfect the work area as necessary based on the activity that was in progress. Consult with the appropriate safety professional if there are any questions.

Releases/Spills Outside of a Biological Safety Cabinet.

Releases or spills outside biological safety cabinets are complex events. The amount released, the physical characteristics of the material, and how the release occurred are important factors in determining the area of involvement. Each release is composed of three somewhat overlapping fractions of the released material.

- First is the bulk of the material that remains in a more or less confluent puddle.
- Second is that portion separating from the main body of material in large drops or small streams.
- Third is that portion which can separate from the main body in airborne particulates of various sizes.

The first two portions comprise the greatest bulk of material that must be disinfected. The third represents only a small portion of the overall bulk with small particles that remain airborne for relatively long periods and transport easily to other areas.

The airborne particles emanating from a biological release are responsible for the initial passive phase of the disinfecting or decontamination procedure. The only required action, in the 30 minutes passive phase, is to isolate the area and allow the occurrence of physical particulate settling with air dilution. Verify that the Biological Safety cabinet nearby is operating. This passive phase reduces airborne particles, per unit volume, permitting the actual disinfecting effort to proceed. During the passive phase, the required Biological Safety kit/station can be distributed, disinfection strategy decided, and entry team decontamination area staged.

The major components of the required Biological Safety kit/station are the containment biohazard bags and personal protective equipment. At a minimum laboratory personnel responsible for the disinfecting or decontamination of a spill should be provided long-sleeved gowns, HEPA-filtered respirators, and medium or heavy rubber gloves. Chemical resistant gloves may be needed due to the disinfectant used or chemicals associated with the release. The gown should be worn over conventional two-piece or jumpsuit type laboratory clothing. Knee length rubber boots are also useful because they are more easily disinfected than conventional footwear and provide greater protection to the wearer against the chemical action of strong decontaminating solutions. Non-laboratory type outer garments should not be worn under the gown. This is not only to preclude potential removal of infectious materials from the laboratory

on personal clothing, but also in recognition of the strong bleaching action of hypochlorites often used in disinfecting or decontaminating releases.

The initial disinfecting or decontamination phase can begin after 30 minutes with the proper personal protective equipment, tools and effective disinfectant (review compatibility with reactive chemicals involved in release) staged and donned. The objective is for the entry team to safely enter the spill area, survey extent of release and primary disinfecting or decontamination. Particular attention should be given to splash materials to avoid tracking around the laboratory. Starting from the outer perimeter of the area, encompassed by the splashed as well as the major bulk of the spilled material, liquid disinfectant should be gently poured around the spill area and allowed to flow into the spilled material. Paper towels soaked with the liquid disinfectant may be used to cover the area. Avoid spraying or pouring disinfecting solutions directly onto the spilled materials or other splashing actions that may create airborne particles containing the released agent. The initial disinfecting or decontamination phase allows 20 minutes contact time of the disinfectant with the spilled agent. Make sure that the amount and concentration of the disinfectant used is sufficient to overcome the inactivating action of proteinaceous media or tissues that may be intimately associated with the agent. A general rule of thumb for a disinfectant is a 10% solution of fresh prepared household bleach, which is adequate for most applications.

During the 20-minute disinfectant contact time, the surrounding area should be observed to locate other potential areas that may harbor the spilled agent. If these areas are extensive or cannot be readily reached with liquid disinfectant, consideration should be given to a follow-up disinfection with paraformaldehyde gas (requires Biological Safety Professional approval). Except in the case of the higher risk infectious agents, materials in difficult to reach with disinfectant solution may not pose a particular hazard for personnel. However, media and other suspending components may provide a haven for spore-forming fungi and bacteria growth that may subsequently prove troublesome in preserving the integrity of experiments.

The follow-up disinfecting or decontamination phase should begin after the 20-minute contact time. Immediate donning of HEPA filtered respirator, if not already in use, is advisable. Isolation of the area may be less important, unless the agent is suspected to have a high degree of infectious potential. Additional liquid disinfectant should be added immediately but gently to the absorbent surface covering; rubber gloves should be worn. Potentially contaminated objects should be wiped down with disinfectant and set aside. All nearby surfaces should be similarly wiped down. The absorbent surface covering should be gently rolled into a compact package, along with the rubber gloves, placed in a container of disinfectant solution or in an appropriate covered container for autoclaving. The investigator should then wash their hands and face with germicidal soap, change to fresh laboratory clothing, and bag used clothing for autoclaving. All laboratory personnel involved in the spill/release should place special attention to follow up

housekeeping procedures, to assure complete disinfecting treatment of surfaces and proper removal of all disposable objects and material involved in the spill.

Decontamination of laboratory spills should also involve common sense. Obviously, all spills do not present the same degree of risk. The preceding discussion is most applicable to relatively large spills of biological materials or for those where a few viable particles may cause infection. Minor spills do occur, however, and may involve very small quantities of agent materials without involving container breakage or significant splashing. If standard aseptic techniques were being used in the laboratory, the spill should occur on a surface protected with an absorbent covering that has been dampened with an effective disinfectant.

8.3.2 Chemical Spills

Spills Involving Innocuous Chemicals. Spills of many innocuous laboratory chemicals can be handled by laboratory personnel with appropriate procedures as outlined below. If laboratory personnel have knowledge of the chemical involved and can discern that the spill does not pose any hazards, clean up may begin without the EHS personnel. Nevertheless, if at any time there is any doubt as to the nature or extent of the hazard, call EHS (2862). Other guidelines include:

- Anticipating spills by having the proper safety equipment on hand.
- Alerting personnel in the area that a spill has occurred.
- Doing what is necessary to protect life.
- Referring to The MSDS for spill information, if applicable.
- Confining the spill if possible.
- Contact EHS if the spill is too large for one person to handle and if it poses a threat to personnel, students or the public; involves an infectious agent; or involves a corrosive, highly toxic, or reactive chemical.
- Contact EHS if there is the slightest doubt as to how to proceed.

Low-Hazard Material Spills. Low-hazard material spills that pose no fire hazard and are not particularly volatile, toxic or corrosive (e.g., salt solutions) require the following measures:

- Use an absorbent material that will neutralize the spill if available, i.e.
    - Trisodium phosphate
    - Sand
    - Sodium bicarbonate for acids
    - Powdered citric acid for bases
    - "Oil-Dri", "Zorb-All", "Speedi-Dri", etc.
    - Paper towels
- A dustpan and brush should be used and rubber gloves and goggles should be worn.

- Decontaminate the area with soap and water after clean-up.
- Place residue in a container for waste collection.
- Contact your supervisor or the EHS (2862) for disposal information.

Volatile, Flammable, or Toxic Material Spills. Adhere to the following guidelines in the event of a volatile or flammable toxic material spill:

- Do not attempt to clean the spill.
- Notify all personnel in the area.
- Extinguish flames and all sources of ignition such as brush-type motors.
- Maintain fume hood ventilation.
- Vacate the area and call for assistance.
- Contact EHS immediately at 2862 and provide them with the nature of the spill. Keep in mind that the following compounds are very hazardous:
    - Aromatic amines
    - Bromine
    - Carbon disulfide
    - Cyanides
    - Ethers
    - Hydrazine
    - Nitriles
    - Nitro compounds
    - Organic halides

APPENDIX A
BIOSAFETY CABINET SUMMARY CHART

The summary chart below compares the different biological safety cabinet types for performance characteristics and applications of use. Biological safety cabinets are among the most effective and most common primary containment devices used in laboratories with biohazardous material.

Type	**FacEVelocity**	**Airflow Pattern**	**Radionuclides/Toxic Chemicals**	**Biosafety Levels**	**Product Protection**
Class I Open Front	75	In at front; rear and top through HEPA filter	NO	2,3	NO
Class II Type A	75	70% recirculated through HEPA; exhaust through HEPA	NO	2,3	YES
Class II Type B1	100	30% recirculated through HEPA; exhaust via HEPA and hard ducted	Yes(Low levels/volatility)	2,3	Yes
Class II Type B2	100	No recirculation; total exhaust via HEPA and hard ducted	Yes	2,3	Yes
Class II Type B3	100	Same as IIA, but plena under negative pressure to room and exhaust air is ducted	Yes	2,3	Yes
Class III	NA	Supply air inlets and exhaust	Yes	3,4	Yes

APPENDIX B
SIGNS AND LABELS

HMIG Label

CHEMICAL NAME	
HEALTH (BLUE)	
FLAMMABILITY (RED)	
REACTIVITY (YELLOW)	
PROTECTIVE EQUIPMENT	

HEALTH INDEX RATINGS

Level	Risk	Toxicity Characteristics
4	Extreme	• On very short exposure could cause death or major residual injury even though prompt medical treatment is given. • A known or suspected human carcinogen, a mutagen, or teratogen.
3	Serious	• May cause serious temporary or residual injury on short term exposure even though prompt medical attention is given. • A known or suspected small animal carcinogen, mutagen, or teratogen.
2	Moderate	• Intense or continued exposure could cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.
1	Slight	• May cause irritation but only minor residual injury even without treatment. • Recognize innocuous materials when used with reasonable care.
0	Minimal	• No chemical is without some degree of toxicity.

FLAMMABILITY INDEX RATINGS

Level	Risk	Flammability Characteristics
4	Extreme	Extremely flammable. Flash point below 73ºF (22.8 C)
3	Serious	Flammable. Will have one or more of the following characteristics: • Vaporizes rapidly and can be ignited under almost all ambient conditions. • May form explosive mixtures with or burn rapidly in air. • May burn rapidly due to self-contained oxygen. • May ignite spontaneously in air. • Flash point at or above 73ºF (28.8 C) but less than 100ºF (37.8 C).
2	Moderate	Combustible. Will have one or more of the following characteristics: • Must be moderately heated or exposed to relatively high temperatures for ignition to occur. • Solids which readily give off flammable vapors. • Flash point at or above 100ºF (37.8 C) but less than 200ºF (93.4 C). .
1	Slight	Slightly combustible. Will have one or more of the following characteristics: • Must be preheated for ignition to occur. • Will burn in air when exposed at 1500ºF (815.5 C) for five minutes. • Flash point at or above 200ºF (93.4 C).
0	Minimal	• Will not burn. • Will not exhibit a flash point. • Will not burn in air when exposed at 1500ºF (815.5 C) for five minutes.

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REACTIVITY INDEX RATINGS

Level	Risk	Reactivity Characteristics
4	Extreme	• Can explode or decompose violently at normal temperature and pressure. • Can undergo a violent self-accelerating exothermic reaction with common materials or by itself. • May be sensitive to mechanical or local thermal shock at normal temperature and pressure.
3	Serious	• Can detonate or explode but requires a strong initiating or confined heating before initiation. • Readily promotes oxidation with combustible materials and may cause fires. • Is sensitive to thermal or mechanical shock at elevated temperatures. • May react explosively with water without requiring heat or confinement.
2	Moderate	• Normally unstable and readily undergoes violent change but does not detonate. • May undergo chemical change with rapid release of energy at normal temperature and pressure. • May undergo violent change at elevated temperature and pressure. • May react violently with water. • Forms potentially explosive mixtures with water..
1	Slight	• Normally stable material which can become unstable at high temperature and pressure. • May react with water to release energy but not violently.
0	Minimal	• Normally stable material which is not reactive with water.

The first (white) section of the HMIG is where the chemical or product name will be printed. The second (blue) section will have a number (0 to 4) indicating the health hazard rating. The third (red) section will have a number (0 to 4) indicating the flammability rating. The fourth (yellow) section will have a number (0 to 4) indicating the reactivity rating. The fifth (white) section will have an alphabetic character (a through k or x) indicating the protective equipment index.

The table indicates the indexes which are placed in the boxes on the right side of the HMIG labels. The numbers and alphabetic characters indicate the hazard or the protective equipment required. The picture next to the alphabetic character represents the PPE needed. The numbers indicate the hazard in ascending order from MINIMAL to EXTREME.

APPENDIX C
LABORATORY SECURITY ISSUES

In response to National Concerns and recent catastrophic events, the following information has recommendations for improving laboratory security. These actions should be taken for your safety and the security of sensitive areas on campus:

1. All areas of the University having electronic locking devices of any type, should make whatever changes to their systems necessary to fully enable the system which results in access by such device at all times.
2. All areas where research is conducted utilizing hazardous material, radioactive material, biohazardous material, and other sensitive materials should have controlled access for authorized personnel only.

Laboratories using biohazardous materials must be kept secured at all times. Several federal, state and consensus standards required that the laboratory doors and hazardous material areas have at a minimum, limited access and required the areas be kept locked when no laboratory staff are present. Security recommendations also include having a routine intra-laboratory inventory mechanism for identifying missing biological, hazardous or radioactive material inventory. This requires an ongoing inventory be maintained.

Laboratories have also experience thefts, many of which occurred because doors were left open and laboratories were unattended. Computers, wallets, and other personal items have been stolen. There has been "unauthorized sharing of supplies" from laboratories. There is also the potential for sabotage to ongoing research. Laboratory Principal Investigators or Supervisors need to take these steps in order provide security against terrorism, larceny, and to remain in compliance with various regulations:

1. All staff should wear university identification badges.
2. Approach any visitors that appear to be wandering in laboratory areas and ask if you can help direct them.
3. Lock all equipment (e.g. freezers, cabinets, incubators and scintillation counters) that may contain biohazardous material and are located in hallways or areas outside of laboratories.
4. Keep laboratory doors closed at all times (they also provide correct air flow and fire safety).
5. Lock laboratory doors when no one is present.
6. Post and keep current the "Emergency Notification Signage" on laboratory doors. Include name of responsible person, a second person knowledgeable with the laboratory and a 24-hour contact number (ASU).

Take an inventory of all hazardous and biohazardous material. Track the use of this material and report any missing inventory to ASU and Environmental Health and Safety.