

Auburn University Lab Safety Manual



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OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION REQUIREMENTS

As part of continuing efforts to provide a safe and healthful work place for students, visitors and employees, Auburn University is implementing the use of a Lab Safety Manual (LSM). A LSM is defined as a written program that specifies procedures, laboratory equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards associated with the use of hazardous chemicals in the workplace. The use of a LSM provides an added measure of protection for students, and employees and the institution, and it makes good sense and good science.

This Lab Safety Manual (LSM) is to be used in every lab that uses chemicals on the Auburn University campus. Components of the LSM include the following:

- Designation of responsible personnel;
- Standard operating procedures for safety and health;
- Identification of particularly hazardous substances;
- Criteria for the implementation of control measures;
- Measures to ensure proper operation of engineering controls and personal protective equipment;
- Provisions for information and Training;
- Laboratory activities requiring prior approval before implementation;
- Provisions for medical consultation and examinations;
- Emergency Procedures.

OBJECTIVES

The primary goal of this program is to ensure the safety and well being of faculty, laboratory instructors, staff, students, and the visiting public will not be compromised in any campus laboratory. To accomplish this, Auburn University is committed to achieving the following goals:

- Maintain a safe environment for all faculty, staff, students, and the visiting public;
- Provide the necessary facilities, staff, and equipment for safety;
- Minimize all chemical exposures;
- Avoid underestimation of risk;
- Provide adequate ventilation;
- Institute a Lab Safety Manual;
- Observe Threshold Limit Values (TLVs) for chemicals;
- Protect the environment from hazardous chemicals and wastes; and

- Conduct laboratory inspections to ensure these goals are being met.

While the Lab Safety Manual is an important part of laboratory safety, not all safety issues involve chemicals. Therefore, it is important to establish additional safety policies and practices regarding biological, physical, electrical, and life safety considerations and incorporate them into the overall laboratory safety program.

RESPONSIBILITY FOR SAFETY

Responsibility for laboratory safety and chemical hygiene in the laboratory rests with the President, the responsible Dean, the responsible Department Head, the Chemical Hygiene Officer (CHO), the Laboratory Supervisor or Principal Investigator (PI), and the Laboratory Worker.

The University President

The University President has the ultimate responsibility to ensure the protection of the health and safety of its employees, students, and visitors in all laboratories within the University. The Deans Directors and the Department Heads must provide continuing support for institutional laboratory safety.

Deans and Department/Unit Heads

The responsibility for safety in a college (or other administrative unit) lies with the Dean of that College. The responsibility for safety in a Department or Unit rests with that Department/Unit Head.

Chemical Hygiene Officer

The Laboratory Safety Program Manager will serve as the Chemical Hygiene Officer (CHO). The CHO is a key component of the LSM. The CHO is a staff member within the Office of Risk Management and Safety (RMS). The CHO monitors the LSM, advises laboratory supervisors on safety matters, and in general serves as a focus for the safety concerns of the laboratory staff. Duties of the CHO are as follows:

- Work with administrators and other employees to develop and implement appropriate chemical hygiene practices and policies;
- Monitor procurement, use, and in conjunction with the Hazardous Materials Manager, disposal of chemicals used in the laboratories;
- Ensure that safety audits are performed periodically;
- Ensure required laboratory safety training is provided;
- Ensure laboratory design is adequate to protect the occupants;
- Understand the current legal requirements concerning regulated substances; and
- Seek ways to improve the LSM.

Laboratory Supervisor or PI

The Laboratory Supervisor or Principal Investigator has the overall responsibility of administering and enforcing the LSM in the laboratory. Duties are as follows:

- Ensure that the laboratory worker understands and follows the LSM and any other laboratory specific safety procedures.
- Ensure that necessary protective equipment is in good condition and available to the laboratory worker.
- Conduct regular, formal laboratory safety and housekeeping inspections, including routine inspections of emergency equipment by utilizing the form found in [Appendix 1](#), Auburn University Laboratory Inspection Form.
- Maintain a proper inventory and storage of the chemicals by utilizing the Chemical Inventory form found in [Appendix 3](#), and the information provided in [Appendix 5](#) Incompatible Chemicals, and [Appendix 7](#) Classes of Peroxidizable Chemicals.
- Ensure that appropriate training is provided to the laboratory worker and that they have read the Lab Safety Manual and [Appendix 6](#) dealing with carcinogens as well as laboratory specific procedures. This training must be documented for each person who works in the lab using attachment [Appendix 4](#), Employee Training Checklist.
- Understand the current legal requirements concerning regulated substances.
- Determine the required level of protective apparel and equipment for a given procedure and ensure it is used.
- Ensure that facilities and equipment are adequate for use of any material being ordered, and ensure training is conducted on the hazards associated with the use of any material.
- Ensure laboratory equipment is properly maintained, and in good working order. Submit work orders or contact vendors to repair any equipment that is not, and prohibit personnel from using it.
- Ensure that good housekeeping and chemical hygiene practices are maintained in the laboratory and that it is kept free from clutter and debris.

Laboratory Worker

The laboratory worker has the following responsibilities:

- Plan and conduct each operation in accordance with the laboratory's safety procedures and LSM;
- Wear all required personal protective equipment;
- Follow all laboratory specific requirements and those in the LSM; and
- Develop good personal laboratory safety habits.

Laboratory Visitors

It is the Laboratory Supervisor or PI's responsibility to ensure the safety of all visitors in the laboratory. Children (under the age of 17) are prohibited entering any laboratory that uses chemicals unless prior approval has been obtained from the Department Head and Chemical Hygiene Officer. Children must be supervised at all times by the Laboratory Supervisor or the PI.

OVERVIEW

This LSM addresses all laboratories and all laboratory employees at Auburn University. The information provided in these procedures satisfies the LSM requirements in 29 Code of Federal Regulations (CFR) 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories.

The purpose of the LSM is to provide general rules and information for chemical safety and to educate serve as a reference source for each laboratory on the requirements of the manual. It is necessary for each College, Department and individual laboratory to supplement this information with laboratory specific procedures. The success of this program will depend on the development and/or implementation of the following information:

- Chemical inventories for each laboratory and storage area.
- Material Safety Data Sheet (MSDS) files for each laboratory.
- Standard Operating Procedures for specific hazardous chemicals used in individual laboratories.
- Information and training programs to meet requirements of these specific procedures.
- A written procedure must be maintained at each laboratory for off hours work, working alone, hazardous work, and unattended operations, and emergency actions. This procedure must also contain emergency contact phone numbers.
- Provisions to meet the medical consultation and examination requirements of the LSM.
- Accurate and up-to-date recordkeeping as required by the LSM.
- Designation of a safety committee or officer per college or department to develop and help implement safety procedures and meet requirements of the LSM.

The Office of Risk Management and Safety (RMS) will be available to assist in the development and implementation of all aspects of the LSM as listed above. All reference material is available through RMS.

STANDARD OPERATING PROCEDURES AND TRAINING FOR EMPLOYEES

Employee Information and Training

All employees should be apprised of the hazards presented by the chemicals in use in their laboratory. Each employee must receive training at the time of the initial assignment to the laboratory, prior to assignments involving new exposure

situations, and/or at a regular frequency as determined by the CHO, and Laboratory Supervisor or PI. The Laboratory Supervisor or PI maintains documentation of training at the workplace.

This training should include methods of detecting the presence of a hazardous chemical, physical and health hazards of chemicals in the lab, and measures employees can take to protect themselves from these hazards. This training should also present the details of the LSM, and include:

- The contents and location of the LSM, and its appendices;
- Procedures that detail the chemical processes being conducted in the lab and a review of the equipment necessary to conduct these processes;
- The permissible exposure limits for OSHA regulated substances or recommended exposure values for other hazardous chemicals not regulated by OSHA which are present in the laboratory;
- Signs and symptoms associated with exposure to the chemicals present in the laboratory; and
- The location and availability of reference material on the laboratory's safety procedures and LSM.
-

Training must be conducted and documented by the Laboratory Supervisor or PI, or his/her designee. Refer to training forms.

Chemical Procurement

It is the responsibility of each department and unit within the University to establish guidelines for the procurement of chemicals. All employees involved in the receiving of chemicals should be informed about proper handling, storage, and disposal procedures. All chemicals should be dated and initialed upon receipt. Chemicals should not be accepted without accompanying labels, Material Safety Data Sheets, and proper packaging. Damaged or leaking containers should not be accepted. Employees should be informed about the proper handling of new chemicals that are known or suspected as hazardous; particularly those that are known, or suspected carcinogens, those with special storage or handling requirements or those with a health hazard rating of 3 or 4.

General Procedures

The following set of general principles should be adhered to by all laboratory staff:

- Know the safety policies and procedures that are applicable to the task at hand.
- Determine the potential physical, chemical and biological hazards and appropriate safety precautions before beginning any new or modified procedure.

- Know the location of all emergency equipment in the laboratory and the proper procedure for each.
- Be familiar with all laboratory emergency procedures.
- Be alert to unsafe conditions and actions, and alert the CHO, Laboratory Supervisor, or Principal Investigator.
- Follow acceptable waste disposal procedures to avoid hazards to the environment.
- Ensure that all chemicals are correctly and clearly labeled.
- Post warnings when unusual hazards exist, such as flammable materials or biological hazards.
- Avoid distracting or startling a coworker.
- Use equipment only for its originally designed purpose.
- Do not work alone in the laboratory if any hazardous procedures are being conducted.
- Do not store, handle, or consume food in the laboratory.
- Never prepare or consume food or beverages in glassware or utensils that have been used in the laboratory.
- Report unusual odors as soon as they are detected to the Laboratory Supervisor or PI.
- Do not use odors as a means of determining that inhalation exposure are or are not exceeded. Whenever there is a reason to suspect that a toxic chemical inhalation limit might be exceeded, whether or not a suspicious odor is identified, notify the Laboratory Supervisor or PI.
- Use safety glasses at all times (except when pouring chemicals, where goggles are necessary) while in the laboratory.
- Use careful handling and storage procedures to prevent damage to glassware.
- Do not use damaged glassware items; either discard or repair.
- Broken glassware must not be handled directly by hand, but must be removed by mechanical means such as a brush and dustpan, tongs, or forceps.
- Report all accidents immediately to the Laboratory Supervisor or PI. An SEH 101 accident report must be completed for every accident, major chemical spill or fire.
- Operations should be ceased when members of the laboratory staff become ill, suspect that they or others have been exposed, or otherwise suspect a failure of any safeguards.

Chemical Handling

Various standardized chemical safety procedures should be followed by laboratory workers:

- Do not use an open flame to heat a flammable liquid or to carry out a distillation.
- Use an open flame only when necessary and promptly extinguish it when it is no longer needed. Do not leave an open flame unattended.
- Before lighting a flame, remove all flammable substances from the immediate area, and check all containers of flammable materials in the area to ensure that they are tightly closed.
- Notify other personnel in the laboratory before lighting a flame.
- Store flammable materials in a flammable storage cabinet.
- Use only non-sparking electrical equipment when volatile flammable materials are present in the laboratory.
- An approved chemical fume hood must be used when pouring, mixing, heating or handling any chemical product.
- Always strive to use the least toxic reagents available.
- Keep all chemicals in closed, clean labeled containers.
- Exercise particular caution when handling carcinogenic, teratogenic, mutagenic, or highly toxic materials, and observe all necessary precautions.

When working with chemicals, all users should know and constantly be aware of the following:

- The hazards identified with the chemical(s) being used. This information is provided in the appropriate MSDS and other sources such as the NIOSH Pocket Guide to Chemical Hazards, and the American Conference of Governmental Hygienists Threshold Limit Values.
- How and where to properly store the chemical(s) when not in use.
- The proper methods for transporting chemicals within the laboratory facilities.
- The safety precautions that are needed when working with the chemical(s), such as the appropriate personal protective equipment.
- The location of, and the way to properly use, all emergency equipment.
- The appropriate procedure for dealing with emergencies, including evacuation routes, procedures for spill cleanup, and proper waste disposal.

Personal Hygiene

All laboratory workers should observe the following practices:

- Whenever a chemical comes in contact with the skin, rinse the area promptly for at least 15 minutes.
- Avoid inhalation of chemical aerosols, dusts, fumes, mists, and vapors. Do not try to determine chemical properties by "sniffing" the chemical.

- Use pipette safety devices such as bulbs or pumps. Do not pipette by mouth suction.
- Wash hands well with soap and water before leaving the laboratory. Do not wash hands with solvents.
- Do not drink, eat, chew gum, smoke, use tobacco products, or apply cosmetics in the laboratory.
- Do not bring beverages, food, tobacco, or cosmetic products into chemical storage or use areas. Also prohibited in the laboratory are microwaves used for food preparation and coffee pots. Refrigerators must not be used to store chemicals must have signs posted prohibiting food storage.

Protective Clothing and Equipment

All laboratory workers should observe the following practices:

- Eye protection with sidepieces should meet the requirements of the American National Standards Institute (ANSI) Z87-1. Safety goggles or face shields are required when the potential for flying objects or chemical splash exists.
- Wear appropriate protective clothing, such as a laboratory coat or apron at all times.
- Confine long hair and loose clothing when in the laboratory.
- When working with corrosive liquids, or with allergenic, sensitizing, or toxic chemicals, wear gloves made of a material known to be resistant to permeation by the chemical. Test gloves for the absence of pinhole leak by air inflation; do not inflate by mouth.
- Do not wear shorts or short skirts when working in the laboratory unless laboratory coats are worn covering the skin to knee level. These coats should be removed each time you exit the laboratory.
- Wear low-heeled shoes with fully covered "uppers". Do not wear sandals or open toed shoes, or shoes made of woven materials.
- Remove gloves when handling equipment, the phone or when leaving the laboratory to prevent the spread of chemical or biological contaminants. For the same reason lab coats should be removed when leaving the laboratory.
- Before using any protective equipment, inspect for defects. Do not use defective protective equipment.

Housekeeping

Safety performance, chemical exposure, and good housekeeping practices in the laboratory are directly related to each other. The workplace should be kept clean and orderly, and chemicals and equipment should be stored in appropriate areas when not in use. The laboratory staff shall follow the general procedures listed below:

- Work areas should be kept clean and free of obstructions. Cleanup should follow the completion of any operation and/or at the end of each day.
- Access to emergency equipment (i.e. safety showers, eyewash fountains, and exits) should never be blocked, even temporarily. Do not park chemical carts in front of any emergency equipment.
- Wastes should be deposited in appropriate receptacles.
- Place broken glass in a separate container.
- Do not store chemicals in aisles, stairways and hallways, or on floors, desks, or laboratory bench tops.
- Equipment and chemicals should be stored properly.
- All chemical containers must be labeled with at least the identity of the contents, the associated hazards, the user, and the name and address of the chemical manufacturer, importer, or other responsible party.
- Keep all work areas clear of clutter, especially bench tops and aisles.
- At the end of each workday, place all chemicals in their assigned storage area.
- Wastes should be labeled properly.
- Clean all working surfaces and floors on a regular basis and clean up spills immediately.

Prior Approval

Employees must obtain prior approval from the Laboratory Supervisor or PI, before proceeding with a laboratory task whenever:

- A new laboratory procedure or test is carried out.
- A toxic limit concentration is likely to be exceeded, or other harm is likely.
- There is a change in procedure or test, even if it is very similar to prior practices. "Change in a procedure or test" is defined as:
 - A ten percent or greater increase or decrease in the amount of one or more chemicals used.
 - A substitution or deletion of any of the chemicals in a procedure.
 - Any change in other conditions under which the procedure is to be conducted.
- There is a failure of any equipment to be used in the process, especially any failure of safeguards such as fume hoods or clamped apparatus.
- The results are unknown.

Chemical Spills

Spills of toxic of chemical substances should be resolved immediately according to the Emergency/Incident Procedures found in section IX, Emergency/Incident

SPECIFIC SAFETY PROCEDURES

Each Laboratory Supervisor or PI must develop a written description of specific safety practices for use in their laboratories' incorporating the applicable precautions described in this manual. Laboratory Supervisors and PI's should read and understand these practices before commencing a procedure.

Procedures for Toxic Chemicals

The MSDS for many chemicals used in the laboratory will state recommended limits and/or OSHA mandated limits as guidelines for exposure. Typical limits are Threshold Limit Values (TLVs), Permissible Exposure Limits (PELs), and action levels. When such limits are stated, they will be used to assist the Laboratory Supervisor in determining the safety precautions, control measures, and safety apparel that apply when working with toxic chemicals.

- All toxic chemical use must occur in a properly functioning fume hood.
- When a TLV or PEL value is less than 50 parts per million (ppm) or 100 mg/m³ (see [OSHA](#)) the chemical must be used with caution. The MSDS must be reviewed prior to use to ensure the appropriate PPE is available for use.
- If a TLV, PEL, or comparable value is not available for that substance, LD (lethal dose) or LC (lethal concentration) values provided on the MSDS should be used. LD₅₀ is the value at which 50% of the test animals will die as a result of ingestion absorption or injection. LC₅₀ typically indicates the same mortality due to inhalation of the substance only.

Table 2.3

Toxicity	Ingestion (mg/kg)*(LD)	Inhalation (LC)	Absorption (mg/kg)*(LD)
Extremely Toxic	≤1	<10ppm	≤5
Highly Toxic	1-50	10-100ppm	5-50
Moderately Toxic	50-500	100-1000ppm	50-500
Slightly Toxic	500-5000	1000-10,000ppm	500-5000

* milligrams of product per kilogram of bodyweight

Procedures for Flammable Chemicals

In general, the flammability of a chemical is determined by its flash point, the lowest temperature at which an ignition source can cause the chemical to ignite momentarily under certain conditions.

- Chemicals with a flash point below 200 degrees Fahrenheit (93.3 degrees Celsius) will be considered "fire hazard chemicals".

- Flammable chemicals should be stored in a flammable solvent storage area or in storage cabinets designated for flammable material. These cabinets must be kept closed at all times.
- Flammable chemicals must be used only in fume hoods and away from sources of ignition.

Procedures for Reactive Chemicals

Reactivity information for a chemical is sometimes supplied in the manufacturer's MSDS or on the label. Guidelines on which chemicals are reactive can be found in regulations promulgated by the Department of Transportation (DOT) in 49 CFR. Also see NFPA Manual 325, Fire Hazards Properties of Flammable Liquids, Gases, Volatile, and Solids; Manual 459, Hazardous Chemical Data; and Manual 491M, Manual of Hazardous Chemical Reactions.

Another complete and reliable reference on chemical reactivity is found in the current edition of the *Handbook of Reactive Chemical Hazards*, written by L. Bretherick.

A reactive chemical is one that:

- Is described as such in Bretherick or the MSDS;
- Is ranked by the NFPA as 3 or 4 for reactivity;
- Is identified by the DOT as:
 - An oxidizer;
 - An organic peroxide; or
 - An explosive, Class A, B, or C;
- Fits the EPA definition of reactive in 40 CFR1361.23;
- Fits the OSHA definition of unstable in 29 CFR 1910.1450; or
- Is known or found to be reactive with other substances.

Reactive chemicals should be handled with all proper safety precautions, including segregation in storage and prohibition on mixing even small quantities with other chemicals without prior approval and appropriate personal protection and precautions.

Procedures for Corrosive Chemicals and Contact Hazard Chemicals

Corrosivity, allergenic, and sensitizer information is sometimes given in manufacturers' MSDSs and on labels. Also, guidelines on which chemicals are corrosive can be found in other OSHA standards and in regulations promulgated by DOT in 49 CFR and the EPA in 40 CFR.

A corrosive chemical is:

- A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact. For example, a chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described by the US Department of Transportation in Appendix A to 49 CFR part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of four hours. This term should not refer to action on inanimate surfaces.
- One that fits EPA definition of corrosive in 40 CFR 261.22 (has a pH greater than 12.5 or less than 2.0); or
- Known or found to be corrosive to living tissue.
- A chemical that can have a destructive effect on combustible materials. This effect can result in fire or explosion.

Corrosive chemicals should be handled with all proper safety precautions, including segregation in storage, storage low to the ground, and appropriate personal protection and precautions. Incompatibilities in storage and research operations should always be avoided and the 'Rule of Thumb' to ALWAYS ADD ACID should be followed.

Procedures for Carcinogens, Reproductive Toxins and Extremely Toxic Chemicals

The procedures described heretofore should be followed when performing laboratory work with any select carcinogen, reproductive toxin, substance that has a high degree of acute toxicity, or a chemical whose toxic properties are unknown. Review [Appendix 6](#) and the [National Toxicology Program](#) to identify if the chemical has been classified as a known or potential carcinogen.

The following definitions apply:

Human Carcinogen - Any substance that will induce a malignant tumor growth in humans following a reasonable exposure, or produces cancers in two or more laboratory animals, or any other substance described as such in the applicable MSDS.

Reproductive toxin - Any substance described as such in the applicable MSDS.

Highly Toxic/Acutely Toxic - Any substance for which the LD50 data described in the applicable MSDS causes the substance to be classified as a "highly toxic chemical" as defined in ANSI Z129.1.

Chemical whose toxic properties are unknown - A chemical for which there is no known statistically significant study conducted in accordance with established scientific principles that establishes its toxicity.

Adverse chemical - For the purposes of this, the chemicals listed in the above four categories will be called adverse.

Designated area - A hood, portion of a laboratory, or an entire laboratory room designated as the only area where work with quantities of the adverse chemicals in excess of the specified limits must be conducted.

Chemicals that are known human carcinogens, mutagens and teratogens shall be used only in designated areas in the laboratory. These areas must be posted and their boundaries clearly marked. Only those persons trained in the use of these chemicals will work in the designated area. Pregnant women must evaluate their work with their immediate supervisor and their physician before working with mutagens or teratogens. All such persons wishing to work with these chemicals will:

- Use the smallest amount of chemical that is consistent with the requirements of the work to be done.
- Use high-efficiency particulate air (HEPA) and/or charcoal filters or high-efficiency scrubber systems to protect vacuum lines, pumps and fume hood exhaust.
- Decontaminate the designated area when work is completed.
- Prepare resulting wastes for disposal in accordance with specific disposal procedures consistent with the Chemical Waste Management Guide from the Office of Risk Management and Safety.
- Store all adverse chemicals in locked and enclosed spaces with a slight negative pressure compared to the rest of the building

Do not wear jewelry when working in designated areas, because the decontamination of jewelry may be difficult or impossible. Wear long-sleeved clothing and gloves known to be resistant to permeation by the chemicals to be used when working in designated areas.

CONTROL MEASURES AND EQUIPMENT

Chemical safety is achieved by continual awareness of chemical hazards and by keeping the chemical under control by using precautions, including engineering safeguards such as fume hoods. Laboratory personnel should be familiar with the precautions to be taken, including the use of engineering and other safeguards. The Laboratory Supervisor or PI should be alerted to detect the malfunction of engineering controls and other safeguards and bring to the attention of appropriate personnel for corrections. All engineering safeguards and controls must be properly maintained, inspected on a regular basis and never overloaded beyond their design.

Ventilation

Laboratory ventilation should be not less than six calculated air changes per hour. This flow is not necessarily sufficient to prevent the accumulation of chemical

vapors. Therefore, when working with toxic chemicals, fume hoods should always be utilized.

Fume hoods should provide 80-120 linear feet per minute of airflow when the sash is open 18 inches.

Laboratory employees should understand and comply with the following:

- Work should not be done if hood has been red-tagged, the low flow alarm is on, the vaneometer indicates no air movement is occurring through the hood, or the user detects chemical odors coming out of the hood. Risk Management and Safety should be contacted immediately to investigate the problem.
- A fume hood is a safety backup for condensers, traps, or other devices that collect vapors and fumes. It is not used to "dispose" of chemicals by evaporation unless the vapors are trapped and recovered for proper waste disposal.
- Any apparatus inside the fume hood should be placed on the floor of the hood at least six inches away from the front edge.
- The sash should be lowered (closed) at all times except when necessary to adjust the apparatus that is inside the hood.
- The fume hood sash should be open no more than 18 inches while the hood is in use.
- The hood fan should be kept "ON" whenever a chemical is inside the hood, whether or not any work is being done inside the hood.
- Personnel should be aware of the steps to be taken in the event of power failure or other hood failure.
- Maintenance personnel should inspect hood vent ducts and fans, following the manufacturer's procedures, at frequent intervals to ensure they are both clean and clear of obstructions.
- Hoods should not be used as storage areas for chemicals, apparatus, or other materials.

Flammable Liquid Storage

Flammable chemicals should be stored in approved cabinets and containers when not in use. Safety cans should be used only as recommended by the manufacturer, and include the following safety practices:

- Never disable the spring-loaded closure.
- Always keep the flame-arrester screen in place; replace if punctured or damaged.

Read and follow the manufacturer's information and also follow these safety practices:

- Store only compatible materials inside a cabinet. (i.e. Never store acids and flammables together.)
- Do not store paper or cardboard or other combustible material in a flammable liquid storage cabinet.
- Follow the manufacturer's established quantity limits for various sizes of flammable liquid storage cabinets; do not overload a cabinet.
- Do not vent flammable storage cabinets and locate them away from flames, oxidizers or heat producing equipment.
- Keep the doors closed at all times when not in use.

The hazard class, and the maximum quantity of flammable and combustible chemicals allowed per 100 square feet of non-sprinklered laboratory space is as follows:

Including quantities in flammable storage cabinets:

Lab Type	Hazard Class	Maximum Quantity/100sqft
Non-teaching lab	I	10 gal
Non-teaching lab	Combination of I, II, IIIA	20 gal
Teaching lab	I	5 gal
Teaching lab	Combination of I, II, IIIA	10 gal

Please see section 3 regarding the maximum quantity of flammable or combustible chemicals allowed per container.

Eyewash Fountains and Safety Showers

Tempered emergency eyewash fountains and emergency shower units must be in accessible locations requiring no more than 10 seconds to reach from the laboratory as specified in the 1998 edition of ANSI Z358.1. For strong acids or caustics, eyewash fountains should be directly adjacent to or within 10 feet (3 meters) of the hazard.

Check the function of eyewash fountains and safety showers on a weekly basis where basins or drains are provided to catch the water. Document this test in the lab's LSM. Eyewash equipment must be capable of delivering to the eyes not less than 1.5 liters per minute for 15 minutes. Be sure that access to eyewash fountains and safety showers is not restricted or blocked by storage or placement of objects or equipment.

The Office of Risk Management and Safety checks safety showers and emergency eyewash stations every 30 days. Check your certification card posted near these systems to ensure it has been done within the last 30 days.

Respirators

Respirators may not be used under any circumstance unless approved by RMS.

The requirements of the Auburn University Respiratory Protection Program must be followed.

For assistance in the Respiratory Protection Program, contact the Office of Risk Management and Safety at 844-4870.

PROVISIONS FOR MEDICAL CONSULTATIONS

All individuals who work with hazardous chemicals should have the opportunity to receive medical attention, including follow-up exams, under the following circumstances:

- When an individual develops signs or symptoms associated with a hazardous chemical they may have been exposed to, they should receive an appropriate medical exam. In addition, they must complete the [Report of Work Related Injury form](#).
- When exposure monitoring reveals an exposure level to be above the action level or PEL for which there are exposure monitoring and medical surveillance requirements, medical surveillance should be established as prescribed by the standard.
- When an event such as a spill, leak, or explosion occurs resulting in the likelihood of a hazardous exposure, medical consultation should be provided to determine the need for a medical examination.

All medical exams and consultations must be performed by or under the direct supervision of a licensed physician and should be provided without cost to the exposed individual, without loss of pay, and at a reasonable time and place. The laboratory supervisor should provide the following information to the physician:

- The identity of the hazardous chemical(s) to which the individual may have been exposed;
- A description of the conditions under which the potential exposure occurred including quantitative exposure information, if available; and
- A description of the signs and symptoms of exposure that the individual is experiencing, if any.

The Office Risk Management and Safety must obtain a written opinion from the physician performing the examination or consultation, which must include the following:

- Any recommendation for further medical follow-up.
- The results of the medical examination and any associated tests.
- Any medical conditions which may be revealed in the course of examination which may place the individual at increased risk as a result of exposure to a hazardous chemical found in the laboratory; and
- Statement that the individual has been informed by the physician of the results of the consultation or examination and any medical condition that may require further examination or treatment. The written opinion should not reveal specific findings of diagnoses unrelated to occupational exposure.

3.0 CHEMICAL HANDLING AND EXPOSURES

GENERAL INFORMATION ABOUT CHEMICALS

NFPA Hazard Identification System

The NFPA 704 Hazard Identification System provides:

1. Planning guidance to the fire departments for safe tactical procedures in emergency operations
2. On-the-spot information to safeguard the lives of fire fighting personnel and others who may be exposed.
3. A means of identifying hazardous materials and areas in which they are stored for students and employees.



It is important to realize that not all chemicals have been rated with the NFPA system. Additionally, the quantity of a chemical can influence the degree of hazard present. The diamond-shaped diagram gives a general idea of the inherent hazards of the chemical, as well as the order of these hazards under emergency conditions such as spills, leaks, and fires.

The diamond is divided into four color-coded quadrants. The top three quadrants of the diamond are labeled with the numbers (0-4) to indicate the degree of hazard for each category: health hazard (blue), fire hazard (red), and instability/reactivity hazard (yellow). The bottom quadrant (white) is used to indicate special hazards: water reactivity, radioactivity, biohazards, or other hazards. In general, the higher the hazard rating, the higher the hazard. It is recommended that the laboratories at Auburn University follow the NFPA system. However, it is vital that within each laboratory the same system be adhered to.

Material Safety Data Sheets

The Hazard Communication Standard (HCS), 29 CFR 1910.1200, provisions have been incorporated into the Laboratory Standard, 29 CFR 1910.1450. The purpose of the HCS is to provide workers with information about potential risks due to chemical hazards in the workplace. The HCS created a "right to know" procedure for the worker who handles or is exposed to hazardous chemicals. Among the various topics covered by the HCS are the labeling of containers, availability of material safety data sheets (MSDS), and the education and training of employees.

All students and employees should have access to the MSDS at all times. MSDS should be filed alphabetically in clearly labeled notebooks and updated as new sheets are received. The notebooks must be kept in an area easily accessible to all individuals in the laboratory. Each MSDS is an excellent source of information, including, but not limited to, physical properties, fire and explosion hazards,

chemical reactivity, recommended protective equipment, and spill and first aid procedures. Because of this, each student and employee should be familiar with the location and types of information available in MSDS. If there are any questions about the material presented in the MSDS, the laboratory worker should contact the Laboratory Supervisor, PI, or RMS for clarification.

Obtaining/Maintenance of MSDS

Prior to ordering a chemical an MSDS should be obtained by the laboratory supervisor or PI, to evaluate potential hazards associated with that chemical and to ensure the proper protective equipment is available for use. Chemical substitution should occur if the chemical is determined to be extremely toxic and/or dangerous to handle. If an MSDS is not received with/or prior to the shipment, the material should be secured until the MSDS is received. Additionally, each time a substance is reordered; an updated MSDS for the material must be obtained and reviewed.

CHEMICAL LABELING

New Chemical Containers

When a new chemical is received, the label on the hazardous material should be checked for consistency against the information provided in the MSDS. In general, labels should contain information about the identity of the material, appropriate hazard warnings, and the name and address of the chemical manufacturer, importer or other responsible party. These labels should never be removed. In addition, when a chemical is received it must labeled with the date received and the responsible party's initials.

Prepared Chemicals

Any container, into which materials are transferred for in-house use should be labeled consistent with the label on the original container. Labels for all hazardous substances should be checked at least monthly to ensure that labels are not defaced, and are intact and accurate.

CLASSIFICATION OF CHEMICALS

There are many ways to classify chemicals. Potential physical and health hazards associated with the use of the chemical are in two classifications. Understanding these classes can further aid in determining the safe handling, storage, and disposal techniques to employ for specific chemicals. Some chemicals may actually fall into more than one class.

Hazard Classifications

Flammable and Combustible

Flammable substances are those that readily catch fire and burn. The vapors from a flammable liquid burn, not the liquid itself.

Flammable liquids are those that have a flash point below 100 degrees F (37.8 degrees C) and a vapor pressure that does not exceed 40 pounds per square inch (psi) at 100 degrees F. A combustible liquid has a flash point at or above 100 degrees F (37.8 degrees C). Many organic acids are combustible materials.

In addition to liquids, the Department of Transportation (DOT) also classifies flammable substances as solids and gases. Examples of flammable gases are acetylene, ethylene oxide, and hydrogen. Flammable solids are those that are capable of producing fire as a result of friction or heat retained from production or that, if ignited, produce a serious transportation hazard.

Explosives

Explosive gases and solids are also part of the flammable and combustible group. Mechanical shock, heat, and certain catalysts can act as initiators of explosive reactions. One example of an explosive mixture is a suspension of oxidizable particles, such as magnesium powder or zinc dust, in air. Explosives include nitrates, chlorates, perchlorates, and picrates.

Pyrophorics

Pyrophoric chemicals are those substances that react so rapidly with air and its moisture that the ensuing oxidation and/or hydrolysis lead to ignition. Ignition may be instantaneous, delayed, or occur only if the material is finely divided or spread in a diffuse layer. Some examples are:

- Finely divided metals, such as calcium, magnesium, and zirconium.
- Metal or non-metal hydrides, such as germanium and diborane.

Water-Reactive Substances

Water-reactive compounds react exothermically and violently with water, particularly if the water is present in limited quantities, since no significant cooling effect will occur. The following are examples of water-reactive substances:

- Alkali and alkaline earth metals, such as potassium and calcium;
- Anhydrous metal oxides and halides, such as calcium oxide and aluminum bromide.

Peroxidizable Substances

Peroxidizable substances slowly react under ambient conditions with atmospheric oxygen to initially form peroxides. The shelf life varies among the various compounds in this group. For more information on peroxides see [Appendix 7](#).

Corrosives

Corrosives include strong acids, strong bases, dehydrating agents, and oxidizing agents. These chemicals erode the skin and respiratory epithelium, damage the eye and cause severe bronchial irritation.

Acids

All concentrated acids can damage the skin and eyes. Nitric, chromic, and hydrofluoric acids are particularly damaging because of the types of chemical burns they inflict. When handling these chemicals appropriate gloves, aprons, and face shields must be used.

Bases

Common bases include sodium hydroxide, potassium hydroxide and ammonia. Metal hydroxides are extremely damaging to the eyes. When handling these chemicals appropriate gloves, aprons and face shields must be used.

Oxidizers

Oxidizers are any material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials. Examples of oxidizers include: hydrogen peroxide, permanganate, and chromic acid.

STORAGE OF CHEMICALS

Proper storage of chemicals is important for the health and safety of the entire laboratory staff. Improper storage can result in hazardous situations that can endanger laboratory workers and physical property. Review [Appendix 5](#) Incompatible Chemicals to identify how to segregate chemicals.

General Storage Rules

The following is a list of important safety rules for the storage of chemicals:

- **Never** store in alphabetical order. Segregate all chemicals according to hazard class then place alphabetically;
- **Never** store chemicals in a fume hood;
- Return all chemicals to their appropriate storage areas at the end of the day;
- Flammable chemicals that need to be refrigerated must be stored in an approved explosion-resistant refrigerator that has been labeled as such;
- Chemicals should not be stored on shelves above eye level;
- Never stack bottles on top of each other;
- Never store chemicals in aisles, stairways and hallways, or floors;
- Store chemicals only on sturdy shelving, which has a raised lip edging, and has been secured to the wall;

- Bottles of flammable liquids should not be stored near combustible materials;
- All chemical containers should be labeled with the date of receipt and the initials of the responsible person.

Inventory

Proper inventory control is essential in the laboratory. All PI's or laboratory managers are required to inventory ([Appendix 3](#)) their chemicals when they set-up their labs. Chemicals that are inherited with the lab should be disposed of if they are of no use. Subsequent receipt of chemicals must be dated, initialed, and included on the chemical inventory list when they are received. Additionally, the following principles are involved in this process:

- Chemicals should be purchased in limited amounts. A six-month supply or less is generally the amount preferred.
- Information about every chemical received, such as date received, manufacturer, and quantity, is recorded to ensure a "cradle-to-grave" record for that substance; refer to [Appendix 3](#), Chemical Inventory Form.
- A first-in, first-out system should be used. This practice ensures less of likelihood that chemicals will deteriorate beyond use or exceed their shelf life.

Chemicals should be examined semi-annually. During the inspection, those chemicals which have the following conditions should be disposed of by the proper procedures:

- those that exceed their appropriate shelf life;
- deterioration of the chemical (visible by change in color; sedimentation or opacity);
- questionable labels or no label;
- leaking containers;
- corroded caps.

Special Considerations

In addition to the general requirements for storing chemicals, various groups of chemicals have special considerations.

Flammables

When flammables must be stored in a refrigerator, an approved flammable material storage or explosion-resistant unit that has been labeled as such must be used. Containers should never be stored in a refrigerator uncapped. Chemical containers should be capped to ensure a seal that is both vapor tight and unlikely to permit a spill if the container is tipped over.

Oxidizers

Oxidizers should be stored to avoid contact with incompatible materials, such as combustible or flammable liquids. Solid oxidizers should not be stored directly beneath incompatible liquids. Oxidizers should be stored on separate shelves with solid vertical and horizontal partitions isolating each shelf. Gaseous oxidizing materials are highly reactive, and can react vigorously with finely divided metals, organic liquids, and other materials that are readily oxidizable. Spilled oxidizers should be placed in a clean, separate container, and disposed of in the proper manner. Oxidizing materials should not be placed in the trash. Spilled materials should never be returned to the original container.

Carcinogens

Storage areas should exhibit the proper warning sign and have limited access.

Compressed Gases

Compressed gas cylinders should be securely strapped or chained to a wall or bench top (see section III.G). When a cylinder is not in use, it must be capped. Cylinders should always be stored in a secured upright position.

Corrosives

Corrosives should never be stored with combustible or flammable material. They should be placed in storage cabinets or in polyethylene trays or containers large enough to contain the contents of the containers. Care must be exercised by the laboratory worker to prevent mutually reactive substances from contacting one another. For example, sulfuric acid should not be stored in the same tray or cabinet as sodium hydroxide.

Water Sensitive and Air-Sensitive Chemicals

Water-sensitive chemicals should be stored away from water sources. Air-sensitive chemicals should be stored under inert gas whenever possible. Containers should be waterproof and/or sealed against air exchange, and inspected frequently. Water-sensitive chemicals, as well as hygroscopic compounds, should be stored in desiccators.

Unstable Chemicals or Chemicals with a Short Shelf Life

Whenever possible, unstable chemicals, or those which have a short shelf life, should be purchased with inhibitors present. Consumption of the chemical should

occur before the inhibitor is exhausted. These substances should be protected from heat, high temperature, rapid temperature changes, mechanical shock, and light.

TRANSFERRING AND TRANSPORTATION OF CHEMICALS

When reagents are transported or transferred between containers, the potential for an accident increases. The laboratory worker must exercise care when performing these procedures. Appropriate personal protective equipment and other safety equipment should be used during these operations.

Transferring Chemicals

When a laboratory worker is doubtful about the proper way to transfer a chemical, the Laboratory Supervisor can provide instruction.

When working with flammable and combustible materials, the laboratory worker should first ensure that no sources of ignition are present in the area. An exhaust hood should be used whenever flammables and combustibles are transferred from one container to another. In addition, when transferring flammable or combustible materials the containers should be bonded and grounded.

It is essential that there be sufficient expansion space within the container being filled. Overfilling a container can result in pressure great enough to cause leakage or rupture. The laboratory worker should be especially conscious of temperature changes that will affect the pressure. For example, a glass bottle with a screw cap lid can rupture if it is filled full to the top with a cold liquid and then stored in a warm or hot area.

Pipeting of liquids should be performed using a laboratory safety pipette bulb or pump. Automatic burettes or pipettes may also be used for the transfer and dispensing of some liquids.

Transportation of Chemicals

The transport of chemicals should always be handled in such a way to ensure the safety of all laboratory personnel. Carts used for transport should be sturdy and have a substantial rim around the edge. Carts should also have wheels large enough to negotiate uneven surfaces, such as expansion joints or floor drain depressions, without tipping or stopping.

Glass Containers

Glass bottles must be protected during transportation within or between buildings. Various types of bottle carriers are available. The bottle tote is designed for transporting acids, alkalis and solvents. Rubber acid buckets may be used for a wide variety of corrosive chemicals.

Safety-coated glass bottles can be purchased from the manufacturer. During transportation, these bottles can provide separation for containers of incompatible chemicals that could react, if mixed. Although the coating provides some protection during transportation, a carrier should always be used when moving a container any substantial distance. In the event of an accidental spill, even with protective film, the bottle and contents must be cleaned up immediately.

Other Containers

Beakers and flasks should be grasped by the neck and bottom. When hand-carried out of the lab, they should be placed in an acid bucket to protect against spillage or breakage or placed on a cart. Jars of solids should be moved in secondary containment (such as a box.)

Compressed Gases

Cylinders should never be dragged or rolled. To protect the valve during transportation, the cover cap should be left in place. Cylinder(s) must be transported using an appropriate carrier.

COMPRESSED GAS CYLINDERS

Many laboratory operations require the use of compressed gases for analytical or instrument operations. Compressed gases present a unique hazard. Depending on the particular gas, there is a potential for simultaneous exposure to both mechanical and chemical hazards. Gases may be combustible, explosive, corrosive, poisonous, inert, or a combination of hazards. Since the gases are contained in heavy, highly pressurized metal containers, the large amount of potential energy resulting from compression of the gas makes the cylinder a potential rocket or fragmentation bomb. Full sized toxic gas cylinders must be stored outside the building and piped in where possible. If this is impractical a ventilated storage cabinet may be used inside the laboratory with appropriate alarms to indicate if leakage has occurred. Careful procedures are necessary for handling the various compressed gases, the cylinders containing the compressed gases, regulators or valves used to control gas flow, and the piping used to confine gases during flow. Additionally all gas connections should be periodically checked for leaks.

Identification

Cylinders

The contents of any compressed gas cylinder shall be clearly identified for easy, quick, and complete determination by any laboratory worker. Such identification should be stenciled or stamped on the cylinder or a label, provided that the label cannot be removed from the cylinder. Commercially available three-part tag systems can be very useful for identification and inventory. No compressed gas cylinder shall be accepted for use that does not legibly identify its contents by name. Color-coding is not a reliable means of identification; cylinder colors vary with the supplier, and labels on caps have little value, as caps are interchangeable. If the labeling on cylinder becomes unclear or an attached tag is

defaced to the point the contents cannot be identified, the cylinder should be marked "contents unknown" and returned directly to the manufacturer.

Lines

All gas lines leading from a compressed gas supply should be clearly labeled to identify the gas, the laboratory served, and the relevant emergency telephone numbers. The labels should be color coded to distinguish hazardous gases (such as flammable, toxic, or corrosive substances) (e.g., a yellow background and black letters). Signs should be conspicuously posted in areas where flammable compressed gases are stored, identifying the substances and appropriate precautions (e.g., HYDROGEN - FLAMMABLE GAS - NO SMOKING - NO OPEN FLAMES).

Handling and Use

Gas cylinders shall be secured at all times to prevent tipping. Cylinders may be attached to a bench top, individually to the wall, placed in a holding cage, or have a non-tip base attached. Cylinders shall never be stored on their side.

When new cylinders are received, they should be inspected. During this inspection, one should insure the proper cap is securely in place and the cylinder is not leaking. Cylinders shall have labels clearly indicating the type of gas contained. The threads on cylinder valves, regulators and other fittings should be examined to ensure they correspond and are undamaged. If the cylinders are acceptable, they shall be stored in a proper location. If a leaking cylinder is discovered, move it to a safe place (if it is safe to do so) and inform RMS (844-4870). You should also call the vendor as soon as possible. Under no circumstances should any attempt be made to repair a cylinder or valve.

Cylinders containing flammable gases such as hydrogen or acetylene shall not be stored closer than 25 feet from open flames, areas where electrical sparks are generated, or where other sources of ignition may be present. An open flame shall never be used to detect leaks of flammable gases. All cylinders containing flammable gases should be stored in a well-ventilated area.

Oxygen cylinders, full or empty, shall not be stored in the same vicinity as flammable gases. The proper storage for oxygen cylinders requires that a minimum of 25 feet be maintained between flammable gas cylinders and oxygen cylinders or the storage areas be separated, at a minimum, by a fire wall five feet high with a fire rating of 0.5 hours. Greasy and oily materials shall never be stored around oxygen; nor should oil or grease be applied to fittings.

Piping material shall be compatible with the gas being supplied. Copper piping shall not be used for acetylene. Plastic piping shall not be used for any portion of a high-pressure system. Do not use cast iron pipe for chlorine; do not conceal distribution lines where a high concentration of a leaking hazardous gas can build up and cause an accident.

When the cylinder needs to be removed or is empty, all valves shall be closed, the system bled, and the regulator removed. The valve cap shall be replaced, the cylinder clearly marked as "empty," and returned to a storage area for pickup by the supplier. Empty and full cylinders should be stored in separate areas.

Where the possibility of flow reversal exists, the cylinder discharge lines should be equipped with approved check valves to prevent inadvertent contamination of cylinders connected to a closed system. "Sucking back" is particularly troublesome where gases are used as reactants in a closed system. A cylinder in such a system should be shut off and removed from the system when the pressure remaining in the cylinder is at least 172 kPa (25 psi/in²). If there is a possibility that the container has been contaminated, it should be labeled as such and returned to the supplier.

Liquid bulk cylinders may be used in laboratories where a high volume of gas is needed. These cylinders usually have a number of valves on the top of the cylinder. All valves should be clearly marked as to their function. These cylinders will also vent their contents when a preset internal pressure is reached, therefore, they should be stored or placed in service where there is adequate ventilation. If a liquid fraction is removed from a cylinder, proper hand and eye protection must be worn and the liquid collected in a Dewar flask.

All compressed gas cylinders, including lecture-size cylinders, shall be returned to the supplier when empty or no longer in use.

Always use safety glasses (preferably a face shield) when handling and using compressed gases, especially when connecting and disconnecting compressed gas regulators and lines.

Transportation of Cylinders

Compressed gas cylinder must be handled carefully and responsibly.

- To protect the valve during transportation, the cover cap should be screwed on hand tight and remain on until the cylinder is in place and ready for use.
- Cylinders should never be rolled or dragged.
- When moving large cylinders, they should be strapped to a properly designed wheeled cart to ensure stability.
- Only one cylinder should be handled (moved) at a time.

CRYOGENIC LIQUIDS

A number of hazards may be present from the use of cryogenic liquids in the laboratory. Employees should be properly trained in these hazards prior to use. The transfer of liquefied gases from one container to another should not be attempted for the first time without the direct supervision and instruction of someone experienced in the operation.

Fire/Explosions

Neither liquid nitrogen nor liquid air should be used to cool a flammable mixture in the presence of air because oxygen can condense from the air and lead to a potentially explosive condition. Adequate ventilation must always be used to prevent the build-up of vapors of flammable gases such as hydrogen, methane, and acetylene. Adequate ventilation is also required when using gases such as nitrogen, helium, or hydrogen. In these cases, oxygen can be condensed from the atmosphere creating a potential for explosive conditions.

Pressure

Cylinders and other pressure vessels used for the storage and handling of liquefied gases should not be filled to more than 80% capacity, to prevent the possibility of thermal expansion and the resulting bursting of the vessel by hydrostatic pressure.

Structural Materials

Appropriate impact-resistant containers must be used that have been designed to withstand the extremely low temperatures.

Contact With and Destruction of Living Tissue

Even very brief contact with a cryogenic liquid is capable of causing tissue damage similar to that of thermal burns. Prolonged contact may result in blood clots that have potentially serious consequences. In addition, surfaces cooled by cryogenic liquids can cause severe damage to the skin. Gloves and eye protection (preferably a face shield) should be worn at all times when handling cryogenic materials. Gloves should be chosen that are impervious to the material being handled and loose enough to be tossed off easily. Appropriate dry gloves should be used when handling dry ice. "Chunks" or cubes should be added slowly to any liquid portion of the cooling bath to avoid foaming over.

Asphyxiation

As the liquid form of gases warm and become airborne, oxygen may be displaced to the point that employees may experience oxygen deficiency or asphyxiation. Any area where such materials are used should be well ventilated. For this same reason, employees should avoid lowering their heads into a dry ice chest. (Carbon dioxide is heavier than air, and suffocation can result.)

GLASSWARE SAFETY

A large percentage of laboratory accidents involve glass. Not only does glass cause cuts and lacerations, but burns may also result from handling hot glassware.

Types of Glass

Nearly all glass used in the laboratory is based on silica. Silica glass may be classified according to its composition, i.e., silica glass, soda-lime glass, lead alkali glass, borosilicate glass, and aluminosilicate glass.

General Safety Considerations

- Laboratory glassware should generally be made of borosilicate glass, unless for unusual applications that would require different characteristics.
- Laboratory glassware should never be used for beverages or food.
- Broken, cracked, scratched, or chipped glassware should be repaired or destroyed and should not be used in the laboratory.
- Broken glass should be discarded in separate containers designed for this purpose. Plastic ware can be substituted for glassware when appropriate.

When inserting glass tubing or a thermometer into a stopper, use the following technique and appropriate personal protective equipment:

- Make sure that the hole is not too small. The hole should be just large enough to grip the tubing. The bore should be one size smaller than one that will just barely fit over the tubing.
- Lubricate the glass tubing with water, glycerol, or other available lubricant.
- Wrap a cloth or paper towel around the glass, or use a glass tubing manipulator. Wrap the stopper with another cloth or towel, or wear a leatherwork glove.
- Grasp the tubing at a point within one to two inches of the end to be inserted into the hole.
- Push the end of the glass into the hole, with a twisting motion, while exerting moderate pressure. Do not twist or push too vigorously.
- When breaking a section of tubing, use the proper procedure and appropriate personal protective equipment.
- Score a line about a third of the way around the circumference with a sharp file.
- Wrap a cloth or paper towel around the tubing.
- With thumbs placed against the sides opposite the score, apply pressure on the glass.

Cleaning

Generally, when cleaning glassware, a simple cleaning with soap and water is sufficient. In some cases more aggressive techniques may be necessary. For biologically contaminated glassware, the contaminated glassware should be autoclaved before cleaning. When using chemicals, such as an acid wash, to further clean glassware, the laboratory worker should be familiar with the proper techniques and appropriate personal protection equipment. The Laboratory Supervisor can provide information on a suitable cleaning agent to use for the specific cleaning situation. Also, under no circumstances should chromium-containing solutions be used. See “The Chemical Waste Management Guide” for additional information on glass cleaners.

ELECTRICALLY-POWERED LABORATORY APPARATUS

The utilization of electrically powered equipment can pose hazards in the laboratory when not used properly. Problems that are encountered when using any laboratory equipment should be reported to the Laboratory Supervisor immediately.

General Concerns

When flammables are present, all motor-driven electrical equipment in the laboratory should be equipped with non-sparking induction motors rather than series wound motors that use carbon brushes. For this reason, kitchen appliances should not be used in the laboratory.

Electrical equipment should be located to minimize any potential contact with water or chemicals. If water or chemicals are spilled accidentally on the equipment, the unit should be unplugged immediately. The equipment should not be used again until it has been cleaned and inspected.

Power cords should always be unplugged before any adjustments, modifications, or repairs are attempted, with the exception of some instrument adjustments. When it is necessary to handle equipment that is plugged in, the laboratory worker should be very careful. The typical laboratory requires a large quantity of electrical power. This increases the likelihood of electrically related problems and hazards. One must address both the electrical shock hazard to the facility occupants and the fire hazard potential. The following recommendations are basic to a sound electrical safety program in the laboratory:

- All electrical equipment shall be properly grounded.
- All electrical equipment shall be UL listed and/or FM approved.
- Sufficient room for work must be present in the area of breaker boxes. All the circuit breakers and the fuses shall be labeled to indicate whether they are in the “on” or “off” position, and what appliance or room area is served. Fuses must be properly rated.
- All electrical cords shall be in good condition.

- Extension cords shall not be used as a substitute for permanent wiring.
- Electrical cords or other lines shall not be suspended unsupported across rooms or passageways. Do not route cords over metal objects such as emergency showers, overhead pipes or frames, metal racks, etc. Do not run cords through holes in walls or ceilings or through doorways or windows. Do not place under carpet, rugs, or heavy objects. Do not place cords on pathways or other areas where repeated abuse can cause deterioration of insulation.

Multi-outlet plugs shall not be used unless they have a built-in circuit breaker. Their use may cause overloading on electrical wiring, which will cause damage and possible overheating.

Most portable multiple outlets are rated at 15 amps. Employees shall check when all connections are made to determine that the total amperage required will never exceed 15 amps. (The amperage on electrical equipment is usually stamped on the manufacturer's plate).

The Facilities Division Electrical Shop shall perform all building electrical repairs, splices, and wiring.

Vacuum Operations

In an evacuated system, the higher pressure is on the outside, rather than the inside, so that a break causes an implosion rather than an explosion. The resulting hazards consist of flying glass, spattered chemicals, and possibly fire. Apply vacuum only to glassware specifically designed for this purpose, i.e., heavy wall filter flasks, desiccators, etc.

Never evacuate scratched, cracked, or etched glassware. Always check for stars or cracks before use.

Vacuum glassware, which has been cooled to liquid nitrogen temperature or below, should be annealed prior to reuse under vacuum.

Rotary evaporator condensers, receiving flasks, and traps should be taped and kept behind safety shields when under a vacuum.

All condensers connected to rotary evaporators should be cooled with recirculating waterbaths. These shall not be operated unattended after hours. The use of a vacuum for the distillation of the more volatile solvents, e.g. ether, low boiling petroleum ether and components, methylene chloride, etc., should be avoided whenever possible. In situations requiring reduced pressure, two alternatives should be considered: utilization of Rotovac System, or solvent recovery via atmospheric pressure distillation (preferred method).

Water, solvents, or corrosive gases should not be allowed to be drawn into a building vacuum system.

Autoclaves

The use of an autoclave is a very effective way to decontaminate infectious waste. Autoclaves work by killing microbes with steam and pressure. Although they are very effective sterilizers, accidents and injury can occur through improper use. In order to safely operate the autoclave the following procedures must be utilized.

- Do not put sharp or pointed contaminated objects into an autoclave bag. Place them in an appropriate rigid sharps container. These can be obtained by calling from Scientific Supply Store.
- Never use red biohazard bags to autoclave. Use blue autoclave bags that can be obtained from the Scientific Supply Store.
- Use caution when handling an infectious waste autoclave bag, in case sharp objects were inadvertently placed in the bag. Never lift a bag from the bottom to load it into the chamber.
- Do not overfill an autoclave bag. Steam and heat cannot penetrate as easily to the interior of a densely packed autoclave bag. Frequently the outer contents of the bag will be treated but the innermost part or an overfull bag will be unaffected.
- Do not overload an autoclave. An over-packed autoclave chamber does not allow efficient steam distribution. Considerably longer sterilization times may be required to achieve decontamination if an autoclave is tightly packed.
- Conduct autoclave sterility testing on a regular basis using appropriate biological indicators (B.stearothermophilus spore strips) to monitor efficacy. Use indicator tape with each load to verify it has been autoclaved.
- Do not mix contaminated and clean items together during the same autoclave cycle. Clean items generally require shorter decontamination times (15-20 minutes) while a bag of infectious waste (24" x 36") typically requires 45 minutes to an hour to be effectively decontaminated throughout.
- Always wear personal protective equipment, including heat-resistant gloves, safety glasses and a lab coat when operating an autoclave. Use caution when opening the autoclave door. Allow superheated steam to exit before attempting to remove autoclave contents.
- Be on the alert when handling pressurized containers. Superheated liquids may spurt from closed containers. Never seal a liquid container with a cork or stopper. This could cause an explosion inside the autoclave.
- Agar plates will melt and the agar will become liquefied when autoclaved. Avoid contact with molten agar. Use a secondary tray to catch any potential leakage from an autoclave bag rather than allowing it to leak onto the floor of the autoclave chamber.
- If there is a spill inside the autoclave chamber, allow the unit to cool before attempting to clean up the spill. If glass breaks in the autoclave,

use tongs, forceps or other mechanical means to recover fragments. Do not use bare or gloved hands to pick up broken glassware.

- Do not to leave an autoclave operating unattended for a long period of time. Always be sure someone is in the vicinity while an autoclave is cycling in case there is a problem.

All Autoclaves should be placed under preventive maintenance contracts to ensure they are operating properly. If the autoclaves are used for medical waste a 40 Hour Steam Sterilization log must be kept. Please review the Medical Waste Management Guide for guidance. This guide is available from RMS (4-4870) or at <http://www.auburn.edu/administration/safety/MedicalWaste.html>

Centrifuges

Each centrifuge operator must be instructed on proper operating procedures of the centrifuge including balancing loads, selection of proper rotor, head, cups and tubes, and use of accessory equipment. Consult the centrifuge operating manual, manufacturer's information and/or other qualified assistance.

Centrifugation presents a physical hazard in the event of mechanical disruption. Aerosols and droplets may also be generated.

Operating procedures for each centrifuge must be established by the laboratory supervisor in accordance with the procedures outlined in the operating manual. Guidelines for centrifugation of infectious agents, chemical hazards and/or radioactive materials must be included in the procedure. Consult the Biological Safety Manual for guidance on centrifuging infectious agents. Call RMS at 844-4870 for a copy or go to <http://www.auburn.edu/administration/safety/BiosafetyManual/Biosafe.html>

Centrifuge Tubes

Plastic centrifuge tubes should be used whenever possible to minimize breakage. Nitrocellulose tubes should only be used when clear, without discoloration, and flexible. It is advisable to purchase small lots several times a year rather than one large lot. Storage at 4°C extends shelf life. Nitrocellulose tubes must not be used in angle-head centrifuges.

All centrifuge tubes should be inspected prior to use. Broken, cracked, or damaged tubes should be discarded.

Refer to operating manual for selection of appropriate tubes, carrier cups, and rotors. Capped centrifuges should be used whenever possible. Do not exceed recommended speeds.

Refrigerators/Freezers

There should be no potential sources of electrical sparks on the inside of a laboratory refrigerator where flammable chemicals are to be stored. Three types

of chemical storage refrigerator/freezers exist—explosion-proof, explosion-resistant, and modified domestic models. If the unit will be used to store flammable or combustible materials the refrigerator/freezer should be explosion-resistant and labeled to indicate they are suitable for storing flammable materials.

The explosion-resistant refrigerator/freezer has a spark-proof, corrosion-resistant interior. The electrical components are encased, and the door gaskets are non-sparking. The explosion-proof variety is engineered for spark-proof operation externally. This type of refrigerator/freezer is hard-wired at installation to meet local electrical codes for maximum safety in hazardous areas, such as a chemical storage room.

All laboratory refrigerators regardless of type should never be used to store human food and must have labels indicating this on the door.

Drying Ovens

Drying ovens are commonly used to remove water or other solvents from samples, and to dry laboratory glassware. Since these ovens do not have a provision for preventing the discharge of volatilized substances into the air, organic compounds should not be dried in these units. Conventional oven units should not be used to dry any chemical that is moderately volatile and might pose a health hazard of acute or chronic toxicity. Glassware rinsed in an organic solvent should not be dried in an oven. Over-temperature control devices must be used when ovens are used unattended after hours.

Thermometers containing mercury should not be used in drying ovens. Instead, a bimetallic strip thermometer is recommended. If a mercury thermometer is used and does break, the oven should be turned off immediately, and RMS called to assist in removing the mercury from the cold oven.

Magnetic Stirring/Hot Plates

When working with flammables, it is imperative that magnetic stirring/ hot plates not produce any sparks. These stirring/hot plates should have non-sparking induction motors.

Water/Steam Baths

The heating elements should be enclosed. The bath should be inspected and cleaned periodically. All tubing must be inspected for cracks and secured with tape or wire where attached to glassware. This will prevent the tubing from becoming detached, causing flooding and potential overheating. Water baths should not be operated unattended after hours.

Lasers

Laser-containing equipment has the potential for causing eye and skin damage. Other hazards associated with this type of equipment include exposures to

cryogenic coolants and accidental electrocutions. Class IIIB and Class IV lasers will not be operated without prior approval of RMS and the Radiation Safety Committee. Additionally, specific facility modifications must be made such as interlocking safety devices on doors. These and other requirements may be found in the Laser Safety Manual at <http://www.auburn.edu/administration/safety/Laser1~1.htm> or call RMS at 844-4870 for a copy.

Miscellaneous Equipment

Equipment should be fitted with a power cord that contains a separate grounding wire. The laboratory worker should exercise caution to ensure that chemicals and water are not spilled accidentally on equipment. If a spill occurs after the equipment is unplugged, the spill should be cleaned promptly. The unit should not be used until it is inspected.

Further information on various units can be found in the manuals supplied by the manufacturer. The Laboratory Supervisor can answer any questions about the proper use of instruments.

Fire Extinguishers

Risk Management and Safety is responsible for the procurement, placement, inspection, and maintenance of all fire extinguishers on campus.

Laboratory personnel should be adequately trained regarding pertinent fire hazards associated with their work. This training can be provided by calling the Office of Risk Management and Safety (844-4870).

Fire extinguishers must be clearly labeled to indicate the types of fire they are designed to extinguish. The following classes as presented in NFPA 10 Portable Fire Extinguishers are:

Class A - fires involving ordinary combustible materials such as wood, cloth, paper, rubber, and many plastics.

Class B - fires involving flammable liquids, oils, greases, tars, oil-base paints, lacquers and flammable gases.

Class C - fires that involve energized electrical equipment where the electrical conductivity of the extinguishing medium is of importance.

Multipurpose extinguishers (ABC) may be used for all the above fires.

Class D - Fires involving combustible metals such as magnesium, titanium, zirconium, sodium, lithium and potassium. These fires require the use of special dry powder extinguishers such as "Purple K", or "Metal X". Each lab that uses these metals should call RMS to obtain this type of extinguisher.

Fire extinguishers should never be concealed from general view or blocked from access.

Please notify RMS (844-4870) if a fire extinguisher needs to be recharged or remounted.

5.0

PERSONAL PROTECTIVE EQUIPMENT

Potential hazards in the laboratory are numerous. Personal protective equipment (PPE) plays a major role in reducing the direct effects of accidents. PPE consists of eye protection, face protection, laboratory coats and aprons, shoes, gloves, and respirators.

PPE should always be used in conjunction with other means of control, such as engineering technology (i.e. fume hoods or auxiliary ventilation), and should never be the primary means of protection when working with chemicals. Because no personal protective equipment or clothing ever extends 100% protection, PPE should be considered secondary protection. PPE does not take the place of proper handling of chemicals and hazardous materials.

While use of PPE can minimize exposures to the hazards encountered in the laboratory environment, the equipment must be used properly. When the laboratory worker is in doubt of proper usage procedures, Laboratory Supervisor or PI can provide appropriate instruction.

EYE PROTECTION

Because of the vulnerability and fragility of the eye, laboratory workers, visitors and students must wear eye protection at all times while in the lab. Eye protection should conform to the Standard for Occupational and Educational Eye and Face Protection, Z87.1, established by the American National Standards Institute (ANSI).

In the event that an accident should occur, eyewash fountains are readily available; refer to VI.A.2, Eye Wash Fountains, for eye wash guidelines. These devices should be inspected regularly to maintain proper working order. Additionally, safety glasses and goggles should be cleaned and inspected frequently for scratches or fogging, and replaced if they are found to reduce visibility.

Safety Glasses

Safety glasses protect the eyes against flying objects and minor splashes. Safety glasses are the minimum acceptable eye protection, and should be made of impact-resistant hardened glass or plastic. Many safety glasses have side shields molded into or attached onto the earpieces. Side shields on safety glasses provide some peripheral protection, but cannot provide adequate shielding from all flying debris and chemical splashes. Goggles or face shields should be worn when significant hazard exists.

Safety Goggles

Safety goggles provide protection for the eye from flying objects or splashing chemicals. To prevent lenses from fogging, impact- protection goggles have

screened areas on the sides to provide ventilation. However, these do not provide full shielding from chemical splashes. When full protection from harmful chemical splash is needed, splash goggles should be worn.

Safety Shields

Portable shields should be non-combustible. They can be made of laminated safety glass or polymeric materials such as polycarbonate or methacrylate. When used on the laboratory bench, safety shields should surround the hazard, with minimum openings to allow maneuvering of apparatus inside. Like safety glasses and goggles, safety shields should be cleaned and inspected frequently. Cracked or pitted safety shields should be replaced. The most common example of a safety shield is the window of a laboratory fume hood. Portable safety shields can also be used on the laboratory counter top.

PROTECTIVE CLOTHING

Laboratory Coats and Aprons

Laboratory coats or aprons should always be worn when working with chemicals. These garments should be replaced if they become perforated or torn. A laboratory coat can provide protection against contact with dirt and minor chemical splashes or spills. It also provides protection for the user's clothing. The laboratory coat does not, however, significantly resist penetration by organic liquids or concentrated acids and bases. If the coat becomes contaminated, it should be removed immediately.

Laboratory coats should be made of cotton or synthetics such as Tyvek or Nomex. Garments should not be made of rayon and polyester due to their tendency to melt and cause greater injury when ignited. Lab coats should always be removed whenever leaving the laboratory so potential chemical or biological contamination is not spread to other areas. In addition, lab coats should be laundered frequently.

Aprons can provide better protection from corrosive and irritating liquids than laboratory coats. They should always be worn when pouring concentrated acids. These are generally made of rubber or plastic and resist penetration better than woven fabric. However, since plastic aprons can be subject to static electricity and therefore may be a source of "sparks", these aprons are not recommended when working with flammables or other materials that may ignite easily. Aprons should be cleaned periodically.

Shoes

Normally, special work shoes are not required. However, open-toed or cloth shoes are unacceptable in the laboratory. While leather shoes offer protection in case of spills, leather readily absorbs organic liquids. If shoes become contaminated, they should be discarded. Disposable shoe covers may be needed when particularly hazardous materials are handled.

GLOVES

When properly selected, gloves can offer protection from exposure to a wide variety of hazardous and infectious substances. Gloves should be chosen on the basis of the materials being handled, the potential hazards involved, and the suitability of the glove to the particular operation being performed.

Thermally Resistant Gloves

Thermally resistant gloves are used when handling exceptionally hot or cold materials. Before each use, gloves should be inspected for punctures and tears and replaced, if necessary.

Chemically Resistant Gloves

Chemically resistant gloves should be worn whenever potential contact exists between the skin and corrosive or toxic materials. Neoprene, polyvinyl chloride, nitrile, and butyl or natural rubbers are the most common glove materials. No one-glove material is right for every task. Information supplied by glove manufacturers/retailers can be helpful in proper glove selection.

Before each use, all gloves should be inspected for discoloration, punctures, and tears. Before removal of any gloves, the user should wash the gloves appropriately. Gloves should be removed before leaving the laboratory and prior to touching doorknobs, telephones, pens or pencils, notebooks, etc. As gloves are eventually permeated by chemicals, they can only be used for limited time periods.

Non-disposable gloves should be inspected carefully before each reuse. Gloves should be replaced periodically, depending on the frequency of use and the permeability to the hazardous materials handled. When possible, disposable gloves should be used.

If there are any questions concerning the proper type of glove materials or proper use of gloves, the CHO, PI or Laboratory Supervisor should be contacted. In addition, glove many manufacturers and suppliers offer web based guides to assist you in the proper selection of gloves for your specific operation.

Gloves for Biological Work

Vinyl or latex gloves are marketed as sterile or non-sterile. There have been no reported differences in the barrier effect between vinyl and latex. Generally, the non-sterile type is suitable for most biological work. Sterile gloves can be used for microbiological work in which there is a chance the gloves may contribute to contamination. When working with human pathogens or blood, double gloving is highly recommended. Single-use disposable gloves should be used for general biological work. Gloves should not be re-used or washed. Gloves contaminated with an infectious agent should be disposed of by appropriate procedures.

General-purpose utility gloves should be used for housekeeping chores. For individuals allergic to latex, vinyl gloves are recommended.

Respirators and Face Masks

Under ordinary conditions, respirators should not be necessary in the laboratory. Respirators may not be used under any circumstances unless approved by RMS and the wearer is in Auburn University's Respiratory Protection program. This program includes a physical evaluation, fit testing and training. If a respirator is thought to be needed, please call RMS and request a hazard assessment to determine if one is required

GENERAL SAFETY EQUIPMENT

Safety and emergency equipment is an integral and important part of each laboratory. This equipment includes fire extinguishers, fire blankets, eyewash fountains, safety showers, laboratory hoods, laboratory sinks, and first-aid and spill kits.

Eye Wash Fountains

An eyewash fountain should be capable of providing a gentle stream or spray of aerated water for an extended period of time, usually fifteen minutes, although 30 minutes may be required. The minimum flow rate should be at least 1.5 liters per minute for 15 minutes.

The eyewash should be located as close to the safety shower as possible, so that the eyes may be rinsed while the body is being showered. Plumbed eyewash units must be activated weekly to flush the line and to verify proper operation.

Safety Showers

Safety showers are for immediate first-aid treatment of personnel contaminated with hazardous materials and for extinguishing clothing fires. Every laboratory worker should be familiar with the location and proper operation of safety showers. Each shower must be activated weekly (where drains are installed) to flush the line and to verify proper operation. The certification card should be inspected to ensure they have been tested in the last 30 days.

The shower should be equipped with a quick-opening valve that can remain open without being held but requires manual closing, since the minimum recommended time of operation is 15 minutes.

Laboratory Fume Hoods

When properly used, laboratory hoods can act as a barrier between the laboratory worker and potential hazards, such as chemical splashes, fires, and minor explosions. Hoods are further discussed in Section 7.0, Ventilation.

Laboratory Sinks

The laboratory sink is essential for safety in the laboratory. Employees must wash their hands with soap and water after removal of gloves, before leaving the laboratory, or when skin comes in contact with hazardous substances. The sink is also used for washing equipment that comes in contact with hazardous materials.

First Aid Kits

A first aid kit should be clearly marked and available to all laboratory workers. The kit should be inspected periodically and the contents replenished as needed. An attached tag or sticker can serve as documentation of inspection.

Spill Clean up Kit

Suggested Items for Small Spill Kit

- Safety goggles
- Lab coat
- Heavy gloves appropriate for the material
- 5 gallon plastic bucket
- Small bag of absorbent (kitty litter)
- Acid/Base neutralization materials
 - Acid spill - sodium bicarbonate
 - Base spill - monosodium phosphate
- Small disposable broom and dustpan

7.0. VENTILATION

HEATING, VENTILATION, AND AIR CONDITIONING SYSTEM

The laboratory Heating, Ventilation, and Air Conditioning system (HVAC), consisting of heating, ventilation and air-conditioning, is an important requirement for laboratory safety. The system provides sufficient input air to:

- Permit proper movement of air, fumes and gases through hood exhausts;
- Prevent migration of noxious and hazardous vapors into other rooms; and
- Provide environmental comfort for personnel.

When a laboratory has a "negative" pressure, more air is exhausted from the room than is provided through the supply system. Negative pressure allows air to flow from the surrounding areas into the laboratory. This prevents odors and contaminants from exiting the laboratory. Air pressure in laboratories shall be negative with respect to corridors and non-laboratory areas.

Ventilation plays an important part in the proper performance of laboratory hoods, in particular the location of room ventilation systems in relation to the fume hoods. The ideal situation is to have these systems located at opposite ends of the lab. Conversely, hoods have the most significant impact of any equipment on the design and efficiency of the building air handling systems. The addition of hoods to an existing HVAC system can unbalance a system where more air is exhausted than can be brought into the building causing the hoods to be less effective. Requests for additional fume hoods must go through RMS and Facilities Division to ensure the proper hood is selected given its intended use, and to review the buildings existing HVAC system to determine if there is adequate make-up air in the building.

Due to potential exposures from contaminants, canopy hoods that pull exposures through the users breathing zone, and recirculating air fume hoods that filter the exhaust and deposit it back into the laboratory, are prohibited for use with chemicals at Auburn University. If discovered such units will be red-tagged until Facilities Division removes them.

Many types of local laboratory exhaust ventilation systems exist, including laminar flow cabinets and biological safety cabinets. Laminar flow or biological safety cabinets shall not be used in lieu of fume hoods. Local exhaust ventilation (e.g. snorkels) may be used provided they have sufficient capture velocities and have been approved by RMS.

LABORATORY FUME HOODS

Many types of laboratory fume hoods exist, including vertical sash, horizontal sash, auxiliary air, and variable air volume (VAV). It should be noted proper hood performance is not equal to average face velocity. Proper hood performance is equivalent to containment of hazardous emissions and control of exposures.

Increasing face velocities will not decrease exposures and may, in some cases, cause them.

Ensuring adequate hood performance is a complex issue and includes many factors including:

- Operation of the building's ventilation system.
- Procedures and work practices including:
- Position and movement of the user,
- Contaminant generation characteristics,
- Contaminant generation location,
- Location of obstructions, and
- Sash position and configuration.
- Laboratory design, including:
- Potential for interfering cross drafts,
- Location of hoods in the lab,
- Proximity of air supply diffusers, and
- Proximity to doors and traffic aisles.

Hoods and their associated ducts should be constructed of nonflammable materials; corrosion resistance should be considered. Electrical outlets and utility controls should be located on the outside of the hood. Glass within the sash should be laminated safety glass at least 7/32 inches thick or equivalent.

General Guidelines for Fume hoods

With particularly hazardous chemicals or wastes, operations such as unpacking, diluting, packing, or reacting hazardous materials should be performed in the fume hood. Weighing operations involving particularly hazardous substances should be performed in a glovebox.

The following general guidelines should be observed for safe and effective use of all fume hoods.

Hoods will be evaluated at least annually by RMS to ensure adequate performance of the hood. A certification sticker will be placed on the hood indicating the date it was certified and the expiration date. Make sure your hood is within its certification date. Never use an inoperative fume hood or one that has been red-tagged. A Fume hood Operation Checklist should also be attached to the sash. Call RMS if you are missing the sticker, it is out of date, or if you need a new checklist.

Chemicals should not be stored in hoods. Chemicals should be returned to their appropriate storage area. Chemical containers can block vents or alter airflow patterns. Only those items that are essential should be in the hood. Extraneous

items may impair the effectiveness of the fume hood. Storing large pieces of equipment in the hood will affect the containment ability of the hood. RMS must be called before storing large equipment in the hood to evaluate the hood performance.

The hood sash should be kept closed unless manipulations are being performed within the hood. When the hood is being used the sash should be open no more than 18 inches or where your hood sticker has been placed. This is necessary to protect the users face in the event of an explosion and prevent chemical exposures when the products used are not being contained by the hood.

Hoods should never be used as a means of disposal for chemicals through evaporation. If vaporization of large quantities of chemicals is necessary as a part of the process, a means of collecting the vapor by distillation or scrubbing should be considered, rather than allowing it escape to the environment. Wastes should be disposed of by established procedures; refer to section 8.0, Laboratory Wastes, for more information.

Hoods may be turned off when not in use if adequate general laboratory ventilation can be maintained when they are not running. Hoods must be left on if any chemicals are in the hood or if the hood is required to maintain negative room pressure.

Materials such as paper and dust should not be permitted to enter the exhaust ducts of the hood. They can adversely affect the performance of the system by lodging in ducts and fans.

Equipment, such as hot plates and heating mantles, should be placed at least 6 inches from the hood sash. Generally equipment should be placed as far to the back of the hood as practical.

Fume hood Performance Determination

In order for a hood to work properly, it must exhaust air properly. The simplest evaluation method is to determine the face velocity of the hood with a hot wire anemometer while the exhaust system is operating. When the hood has its own exhaust blower and is located in a room with additional hoods, all hoods should be turned on during testing. In a central exhaust system, all hoods should be in operation.

The evaluation is performed by RMS and is conducted annually. The results are recorded and expressed in feet per minute. A certification sticker is placed on the hood indicating the date it was certified, the inspector, the flow rate, the location of the fan(s) that serve the hood, and the maximum sash height. The sash should never be raised above this level except to add or remove equipment from the hood. If a hood does not meet the minimum airflow requirements it will be red-tagged and a work order and/or report shall be submitted to Facilities Division by RMS. Under no circumstances shall a red-tagged hood be used and it is the

responsibility of every Researcher, PI, Lab Supervisor, or Instructor to ensure this. When it has been repaired Facilities Division will notify RMS so the hood can be recertified. If the Lab fails to follow-up to ensure a red-tagged hood is repaired, or decides not to repair it, the hood will be emptied and locked down to ensure it is not used until such time it is repaired and recertified.

Hood Baffles

The adjustable back baffle device in a hood provides more control of the exhaust system by more evenly distributing the air across the face of the hood. Baffles usually have movable slot openings at both the bottom and top, and sometimes in the center. The relationship of openings at the top and bottom has a major and deciding role on the manner in which the hood operates. When air enters the hood, it is divided into two segments: floor sweep and vortex (circular and turbulent air pattern). The floor, or work surface sweep, is the zone from the work surface to approximately 8 inches above the floor of the hood. The semi-neutral zone is from the 8-inch height to 20 inches above the work surface. The vortex is from 20 inches above the floor to the top of the chamber. If the baffle slots are not properly adjusted, the vortex can move the generated fumes from the back of the hood to the front.

Except for heat induced density changes, almost all vapors generated from chemical and biochemical reactions have a heavier- than-air density. Therefore, the bottom baffle slot should usually be left wide open. The top slot should be adjusted to an opening of 0.5 inches unless there is a high heat loading, when the opening should be adjusted to 1.5 inches. Baffle positions will be set when the hood is installed and certified and should never be adjusted by the user.

BIOLOGICAL SAFETY CABINETS

A biological safety cabinet is not a chemical fume hood and should not be used as such. However, the biological safety cabinet is the most effective primary containment device in the laboratory for infectious agents. There are three types: Class I, II, and III.

The use of a cabinet alone may not be sufficient, especially when aerosols are produced. Other personal protective equipment may be needed; refer to Section 5.0. The operational efficiency of the biological safety cabinet should be specially tested and the system recertified annually by qualified, trained RMS personnel. HEPA filters should be changed when they fail to meet testing requirements established by the National Sanitation Foundation (NSF) in NSF Standard 49.

Classes of Biological Safety Cabinets

Class I biological safety cabinet: A Class I biological safety cabinet is an open-fronted, negative pressure unit with a minimum inward velocity at the working opening of at least 75 fpm. There may be a full-width open front, an installed front closure panel not equipped with gloves, or an installed front closure panel

equipped with arm-length rubber gloves. While the Class II cabinet has the same minimum inward velocity as that of the Class I cabinet, the Class II unit has vertical laminar flow in addition to a HEPA (high efficiency particle arrestor) filter that provides recirculated air within the workspace. The exhaust air is also cleaned by HEPA filters.

Class II Biological Safety Cabinet: The Class II biological safety cabinet is used for most microbiological work. The use of a Class II cabinet combined with good laboratory techniques not only protects the worker from infectious agents, but also additionally protects the materials from airborne contaminants. Furthermore, this cabinet is the most suitable location for opening packages containing pathogenic microorganisms. While Class II units produce a very high quality, low particulate environment, non-particulate toxic, flammable, or explosive materials are not removed by HEPA filters, and are sent back into the room. Chemical preparations and reactions should be carried out in a chemical fume hood.

Class III Biological Safety Cabinet: A Class III cabinet is a totally enclosed, ventilated cabinet of gas-tight construction in which manipulations are conducted through attached rubber gloves. In addition to a HEPA filter system for the supply air, there are two HEPA filters installed in series to cleanse the air prior to exhaust.

DISPOSAL OF CHEMICAL WASTES

Academic laboratories must meet disposal regulations set forth by Federal, State and local governments. Methods of disposing of laboratory wastes and unused chemicals must be safe and environmentally acceptable. Planning for the disposal of substances should be as much a part of the experiment as the actual laboratory procedure. Disposal problems can be greatly reduced by planning procedures to reduce the amount of hazardous materials generated. The Office of Risk Management and Safety has prepared Chemical Waste Management Guide, which discusses in detail the procedures for chemical disposal. It can be found at http://web6.duc.auburn.edu/administration/safety/Haz_Was_Disposal.pdf or a copy can be obtained from RMS at 844-4870.

Hazardous Waste Disposal

The University is classified by EPA as a large quantity generator of hazardous waste, which means that the University generates more than 1000 kilograms of hazardous waste or more than 1 kilogram of acutely hazardous waste in a calendar month. As a large quantity generator, the University cannot store hazardous waste at its hazardous waste accumulation site, without a permit, for more than 90 days. All hazardous wastes must be properly identified, labeled and stored. There are a number of ways that a waste can be hazardous:

Ignitable: An ignitable waste has a flash point less than 140 degrees F or is easily combustible. Examples are solvents or paint wastes.

Corrosive: A corrosive waste with a pH less than or equal to 2 or greater than or equal to 12.5 and can dissolve metals, other materials, or burn the skin. Examples are acids and bases.

Reactive: A reactive waste is unstable or undergoes rapid or violent chemical reaction with water or other materials. Examples are explosives and flammable solids.

Toxic: A toxic waste contains one or more of the constituents listed in Table 1-1 of the Chemical Waste Management Guide. A Toxicity Characteristic Leaching Procedure (TCLP) is used to identify these wastes. Examples include heavy metals and many organic compounds. All laboratories that dispose of chemicals must have a copy of the Chemical Waste Management Guide to determine how to properly manage your wastes. When in doubt treat all wastes as if they are hazardous. Unknown materials must be identified before they can be sent for treatment and disposal. This can become quite expensive. Good laboratory practices dictate that all chemical containers should be properly labeled. Following this practice will eliminate unknowns.

Hazardous Waste Storage and Pick-up Procedures

Review the Chemical Waste Management Guide (CWMG) for the hazardous waste storage and pick-up requirements. When you are ready for a pick-up, contact RMS at 844-4805. Pick-ups are done on Tuesdays and Thursdays, typically within one week of your initial telephone call. Failure to follow the procedures outlined in the CWMG will result in your material not being picked up. If you need assistance or have any questions, please call the Hazardous Materials Manager at 844-4805.

Minimization of Wastes

In accordance with the Auburn University Waste Minimization Policy, whenever possible, waste should be minimized. This is the least expensive approach to waste disposal. Wastes may be minimized by:

- Recycling
- Inventory Control
- Material Substitution

For more information on waste minimization call the RMS Hazardous Materials Management personnel at 844-4805.

PROCEDURE FOR LABORATORY CLOSEOUT OR TRANSFER

Proper disposition of all hazardous materials used in laboratories is the responsibility of the principal investigator or researcher to whom a laboratory is assigned. Ultimate responsibility for hazardous materials management lies with each department. Proper disposition of hazardous materials is required whenever a responsible individual leaves the University or transfers to a different laboratory. ("Responsible individual" can include faculty, staff, post-doctoral and graduate students.)

If improper management of hazardous materials at closeout requires disposal services from an outside contractor, (i.e. presence of outdated peroxide forming chemicals) the responsible department will be charged for this service. The laboratory supervisor is also responsible for identifying all unlabeled chemicals. These "unknowns" must be classified prior to disposal. If the disposal company has to characterize the unknown waste, the responsible department will be charged for these services. Under no circumstances will unknown chemicals be disposed of through the sanitary sewer to avoid costs.

Any regulatory action or fines resulting from improper management or disposal of hazardous materials will accrue to the responsible department. RMS will not be responsible for loss incurred by individuals or departments as a result of regulation-mandated removal of hazardous materials.

Chemicals

Assure that all containers of chemicals are labeled with the name of the chemical. All containers must be securely closed. Beakers, flasks, evaporating dishes, etc. are not acceptable. Waste chemical tags must be completed for each container (see the Chemical Waste Management Guide for instructions). Chemical wastes must not be placed in the sanitary sewer or trash; they must be collected for disposal. Check refrigerators, freezers, fume hoods and bench tops as well as storage cabinets for chemical containers.

Determine which chemicals are usable and transfer responsibility for these materials to another party who is willing to take charge of them. If a new user cannot be found, the materials should be disposed.

All other chemicals should be prepared for disposal or recycling. Detailed instructions are available in the University's Chemical Waste Management Guide. This process may take quite some time and should be started at least a month before departure from the laboratory. Chemical pickup must be completed before the laboratory is vacated. Waste collection will take at least a week after submitting forms to RMS. Unlabeled materials will take longer.

Equipment

If laboratory equipment is to be left for the next occupant, clean or decontaminate it before departing the laboratory. If exhaust or filtration equipment has been used with extremely hazardous substances or organisms, alert RMS and Facilities Division personnel.

If laboratory equipment is going to be disposed of (not sold by Surplus Property), be aware that capacitors, circuit boards, transformers, mercury switches, mercury thermometers, radioactive sources and chemicals must be removed before disposal.

If laboratory equipment is to be sold by Surplus Property, it must be decontaminated prior to transfer. The equipment should be denoted as having been decontaminated.

Decontaminate fume hood surfaces, counter tops and the interior of all freezers and refrigerators.

Notify Department Head when laboratory has been cleared.

Controlled Substances

Controlled substance permits are issued by the US Drug Enforcement Agency (DEA) and are issued to individual researchers.

Abandonment of a controlled substance is a violation of the DEA permit under which it was held. Permission to transfer ownership of a controlled substance to another individual must be received from DEA. Controlled substances being held by a licensed individual can be disposed of by following the DEA guidelines.

If controlled substances for which the licensee is unknown are found, contact RMS (844-4805).

Gas Cylinders

Remove gas connections, replace cylinder caps, and return cylinders to suppliers. If cylinders are non-returnable, or found abandoned, contact RMS at 844-4805.

Animal and Human Tissue

If tissue is held in a liquid preservative, tissue and liquid should be separated. If the tissue is in a recognizable form, contact, 844-4805 for disposal assistance.

Animal tissue can be disposed by rendering (large animal parts) and by placing them in a non-leaking trash bag for incineration. Do not place these items in a biohazard bag.

Liquid preservative usually needs to be disposed as a hazardous waste. Contact RMS (844-4805) for disposal assistance. Do not assume that the preservative can be disposed of in the sanitary sewer.

If samples need to be saved, locate appropriate person to take responsibility for them and notify the Department Head.

Microorganisms and Cultures

Autoclave all cultures of microorganisms and dispose in regular trash. If material cannot be decontaminated, follow the Medical Waste Management Guide for disposal. A copy is available by calling 844-4870 or at <http://www.auburn.edu/administration/safety/MedicalWaste.html>

Decontaminate incubators, drying or curing ovens, refrigerators and freezers.

If samples need to be retained, locate appropriate person to take responsibility for them and notify the Department Head.

Radioactive Materials

A laboratory in which radioactive materials have been used may not be released for unrestricted use or transferred to a new Principal Investigator until it has been decommissioned by the Radiation Safety Officer (RSO).

Similarly, any equipment which has been used for radioactive material work (e.g. centrifuges, refrigerators) may not be surplus, transferred, or disposed of until it is surveyed by the RSO and found to be free of contamination.

Contact the RSO at 844-4870 to arrange for laboratory decommissioning or equipment surveys.

Mixed Wastes

Occasionally it is necessary to dispose of materials that contain more than one of these hazards. Contact the RMS for mixed chemical, radioactive, or biological agent assistance.

Equipment potentially contaminated with radioisotopes should be surveyed by the RSO (see above).

Shared Storage Areas

Departing researchers must carefully survey any shared facility in order to locate and appropriately dispose of their hazardous materials, equipment, or other unwanted items.

Regulatory impact

Mishandling of hazardous materials can result in citations, fines and/or loss of right to use hazardous materials. Adverse publicity is also a frequent result. Fines will be the responsibility of the department incurring them.

9.0

EMERGENCY/INCIDENT PROCEDURES

All emergencies or incidents (fire, major chemical spill, explosive chemical) must be immediately reported to the Auburn Police (DIAL 911). Reference Auburn University Disaster/Crisis Plan copy in departmental office.

INCIDENT RESPONSE PROCEDURES

Upon notification of an emergency or incident (fire, chemical spill, and explosive chemical) the staff of the Risk Management and Safety (RMS) will be called for work as determined by the Executive Director of RMS. During off hours and weekends the Auburn Police are to be contacted with regard to any chemical spills, fire, or explosive chemicals. In the event of a major spill, 911 should be contacted immediately.

Fire Evacuation Procedures

When evidence of fire and/or smoke is detected, University faculty/staff/students are instructed to use four basic guidelines in the following order of importance:

- Activate the fire alarm pull station, or shout, “FIRE” if there is no alarm.
- Evacuate the area.
- Call 911. Give specific information, such as building name, floor, room number, and whether chemicals are involved. Arrange for someone to meet the fire fighters outside the building.
- Close doors to help control spread of smoke and fire.

Be sure that everyone in the building or area is aware of the fire alarm pull station locations and these procedures.

Evacuation Procedures for Persons with Disabilities

Learn location of nearest exits.

Use buddy system; have designated/assigned individual assist disabled persons to exit or designated area of refuge.

Method of Reporting and Incident Investigation

The Laboratory Supervisor or PI will complete a memo and an RMS 101 form detailing the events leading up to the fire and what corrective actions will be implemented to prevent future occurrences. Upon receipt of the memo/RMS 101, RMS staff will follow up with an investigation of their own, working with the Department involved, Facilities Division, Auburn Fire Department, and the State Fire Marshal when required. A report of their findings will be provided to all parties as well as recommendations of corrective actions that will be implemented.

Chemical Spills

The following definitions of spills are used to assist in determining the level of clean-up assistance necessary.

- Simple Spill: Determine if the laboratory has the proper material; e.g., absorbents and containers, to commence cleanup. If necessary, adequate material is available through RMS.
- Complicated Spill: Occupants should evacuate immediately and contact 911. RMS personnel will be notified and will contact the Building Coordinator and Facilities Division to assist in shutting down the buildings HVAC system. Ensure that all personnel are cleared from the area and that all experiments and processes are safely shut down. No one should be admitted to the area until the problem has been alleviated.

In the event of any major spill, 911 is to be contacted concerning any chemical spill. 911 staff will then contact the RMS person best suited to respond to the incident.

Explosive Chemicals

Upon receipt of request for assistance with, or notice of, potentially explosive chemicals, the following actions will be taken by RMS:

- Inspect the suspect material. Determine hazard potential. Seek available assistance from faculty or lab personnel involved, Sponsored Research, Chemistry Department or other qualified professionals.
- If determined that explosive potential exists and the material must be removed:
- Contact the Hazardous Materials Manager who will provide guidance and locate an independent contractor who is licensed to remove and dispose of explosive materials.
- If immediate danger exists, notify Auburn Police who will make arrangements for pickup by the Auburn City Fire Department and the Opelika Hazardous Materials Team, and take care of building evacuation when required.
- After material is removed, observe disposal and file necessary reports.

In all cases, RMS will ensure that Auburn Department of Public Safety, Auburn Fire Department, College Deans, Department Chairs, Building Supervisors and Researchers in the affected building/area are notified. RMS will endeavor to provide notification 24- 48 hours before removal, but will not compromise the safety of the building occupants or facilities.

Appendix 1
Lab Inspection Form

Auburn University Lab Inspection Form

Status		C/A Description	Question	Corrective Action
YES	NO			
		Emergency postings	Is the Auburn University Emergency Contact list posted?	Post Auburn University Emergency Contact list in a highly visible area in each laboratory. Refer to the RMS/Laboratory Safety webpage (www.auburn.edu/rms) for a copy of the list.
		Door sign	Are doors signs up to date and appropriate for laboratory operations?	Post Auburn University Emergency Contact list in a highly visible area in each lab. Refer to the RMS/Laboratory Safety webpage (www.auburn.edu/rms) for a copy of the list.
		Egress	All means of egress (exit, exit access and discharge) clear and unobstructive?	All means of egress (exit, exit access and discharge) Must be free and unobstructed. No material or equipment may be placed, either permanently or temporarily, blocking the exit routes. Also, exit doors may not be locked preventing laboratory personnel from freely exiting the area.
		Security	Is laboratory security sufficient?	Limit or restrict access to the lab when working with infectious agents or radioactive materials.
		BUA	Are Biological Use Authorizations (BUAs) on file and current?	Amend BUAs to reflect changes in personnel, lab locations/room numbers, procedures, organisms, etc. Renew or close BUAs that are expiring within the next 30 days. Refer to RMS/Biosafety webpage for the BUA Renewal/Closure Form. (www.auburn.edu/rms)
		Form X	Is Alabama Department of Public Health (ADPH) Form X, Notice to Employees, posted in a clearly visible location?	Post Alabama Department of Public Health (ADPH) Form X, Notice to Employees in a clearly visible location. For a copy of the form, refer to RMS/Radiation Safety webpage. (www.auburn.edu/rms)
		Signage	Is laboratory equipment /devices/supplies properly labeled?	Refrigerators, microwaves, ice machines, incubators, etc. shall be marked with “No Food or Drink” signs. Refrigerators used for storing human food shall be marked with “Human Food Only” sign. Food items used for research shall be marked with “Not for human use/consumption” stickers.

Status		C/A Description	Question	Corrective Action
YES	NO			
		Labeling of all Radiation Hazards	Are radioactive materials/ radiation work area(s)/ equipment /other radiation hazards properly labeled, as well as posted signs for (x-rays, lasers, RF, UV, etc.)	Place appropriate radiation warning labels on any and all equipment/storage containers used for working with or storing of radioactive materials. Post appropriate warning signs identifying other radiation hazards. This includes labeling of x-ray, lasers, RF, UV, etc.
		Labeling	Are laboratory equipment/devices/ supplies properly labeled?	Place “Biohazard” stickers on any and all equipment/storage containers used for working with or storing of biohazardous materials. Refrigerators and microwaves used for research must also be marked with “No Human Food” sign. Refrigerators and microwaves that are used for storing/preparing human food, should be located in designated break areas, and shall be marked with “Human Food Only” signs. Food items used for research shall be marked with “Not for human use/consumption” stickers.
		Eyewash	Is eyewash readily available?	BL1 labs- Installation of eyewash station is recommended .BL2 and BL3 labs- Installation is required. Eyewash stations shall be inspected weekly by laboratory workers and documented on a log and posted at or near the eyewash station. Installation and maintenance shall be scheduled with the Facilities Division. Consult RMS prior to installation to ensure compliance with ANSI
		Hand washing	Is sink and soap readily available for hand washing?	BL1 labs- If hand washing facilities readily available, use an alcohol-based product and then wash hands with soap and water as soon as possible. BL2 labs and BL3 labs – Each laboratory shall contain a sink and soap for hand washing. Foot, knee, or automatically operated sinks are recommended.

Status		C/A Description	Question	Corrective Action
YES	NO			
		PPE	Is Personal Protective Equipment (PPE) available and appropriate?	PPE must be available and appropriate for the work being performed. PPE shall not be worn outside of the lab. For guidance on selecting appropriate PPE, refer to RMS/Laboratory Safety webpage. (www.auburn.edu/rms)
		Absorbent paper	Is absorbent paper used on work surfaces where unsealed radioactive material is used?	Place absorbent paper on work surfaces where unsealed radioactive material is used.
		Bench tops	Are proper bench tops in place?	Replace bench tops with materials that are impervious to water and resistant to moderate heat. They shall also be resistant to the organic solvents, acids, alkalis, and chemicals used to decontaminate the work surfaces
		Furniture	Is appropriate laboratory furniture available?	BL1 labs- Replacement or covering of cloth chairs is recommended. BL2 and BL3 labs- Replacement or covering of cloth chairs is required. Chairs shall be of the non-fabric type that can be easily decontaminated.
		Spill Kit	Is a spill kit readily available?	Purchase or assemble a spill kit, place in an easily accessible area, and train lab workers on location and use of kit. Refer to the RMS/Laboratory Safety webpage for suggested list of supplies/items. (www.auburn.edu/rms)
		First aid kit	Is a First Aid Kit available/maintained?	Purchase or assemble a First Aid Kit. Maintain, inspect contents, and date the kit indicating when it was last inspected.
		Autoclave	Is autoclave use log available / current, and are autoclaves tested after 40 hours of combined operation?	Each sterilizer shall be evaluated for effectiveness under full loading by an approved method at least once for each 40 hours of combined operation. Biological indicators such as spores of “Bacillus stearothermophilus” shall be utilized. A written log or other means of documentation shall be maintained for each steam sterilization unit. For information, refer to the RMS/Biosafety webpage.

Status		C/A Description	Question	Corrective Action
YES	NO			
		BSC/ Fume hoods	Are Biological Safety Cabinets (BSCs)/Laminar Flow hoods, and/or fume hoods certified?	BSCs/Laminar Flow cabinets- Margaret Smith, our Laboratory Safety Officer, will contact you to set up a date/time for recertification /maintance of your cabinet. Fume hoods are certified by RMS staff on an annual basis and does not require a request.
		Fume hood off	Is the hood left running at all times?	Always keep fume hood(s) running. This practice helps to maintain adequate air flow inside the laboratory and prevents the formation of potentially hazardous atmospheres.
		Fume hood work zone	Is equipment, supplies, and/or chemicals used inside the fume hood appropriately positioned?	Maintain the sash height at 18" while working inside the fume hood. A sash height greater than 18" creates improper air flow inside the hood. The sash shall be kept closed when not working in the fume hood.
		Perchloric acid hoods	Is a perchloric acid hood used for all work with perchloric acids?	Perchloric acid hoods, with wash down capabilities, must be used for all work performed with perchloric acids.
		Fume hood storage	Is the fume hood used for intended use and not for storage?	Avoid using the fume hood for storage. Equipment, supplies, and /or chemicals stored in the hood can impede air flow and result in personnel exposure. Note: Keep the sash closed when not in use.
		Survey instruments	If required, are radiation survey instruments available and calibrated?	When required, all radiation labs shall have access to Geiger Meters (GMs) when working with radioactive materials. Note: GMs will be calibrated annually by RMS/Radiation Safety personnel.
		Dosimeters	If required, are radiation dosimeters (badges) in use?	When required, radiation dosimeters (badges) shall be worn at all times, when working with radiation sources.
		Semi-annual contamination surveys	Are semi-annual contamination surveys performed/documented?	No corrective actions required. Semi-annual contamination surveys will be performed by RMS/Radiation Safety staff and problems will be reported to the Principal Investigator (PI).

Status		C/A Description	Question	Corrective Action
YES	NO			
		Contamination survey results	Were the lab contamination surveys negative?	Contaminated areas/equipment/supplies shall be cleaned immediately, depending on action guidelines in Radiation Safety Manual.
		Training	Is initial and annual radiation training documented?	Document initial and annual radiation training. For a sample training documentation form, refer to the RMS/Laboratory Safety webpage. Training records should be maintained in the lab and available upon request.
		Pipetting	Are mechanical devices available for pipetting?	Purchase/provide mechanical devices for pipetting.
		Radioisotope inventories	Are radioisotope inventories available and up-to-date?	Maintain/update radioactive inventory as needed.
		Post-use contamination surveys	Are radiation surveys being preformed after each use of material?	Perform laboratory contamination survey after each use of radioactive materials.
		Monthly contamination surveys	If required, are monthly meter and swipe surveys preformed/ documented?	When required, perform monthly meter and swipe surveys. Note: Results shall be reported to Radiation Safety.
		Chemicals dated/initialed	Are chemicals dated and initialed upon opening?	RMS recommends dating and initialing all chemicals upon receipt and upon opening.
		Chemical storage signs	Are all chemical storage areas adequately identified?	Clearly mark all designated chemical storage areas.
		Liquid chemical storage	Are all liquid chemicals stored below eye-level?	Store all liquid chemicals low to the ground, at least below eye-level, and preferably using secondary containment.
		Containers labeling	Are all containers labeled with the name of its contents?	Label all containers with the name of its contents. Remove degraded labels and replace with legible labels.
		Flammable storage	Are all flammables stored appropriately?	Flammables (less than 10 gallons) – shall be stored together and away from heat sources. Flammables (greater than 10 gallons) – shall be stored inside an appropriate flammable cabinet.

Status		C/A Description	Question	Corrective Action
YES	NO			
		Reactive chemicals storage	Are highly reactive chemicals stored in chemical-safe refrigerators?	Store flammable/explosive chemicals must be stored in an explosion resistant/proof refrigerator. Household refrigerators are not acceptable for storage of these type chemicals.
		Chemical compatibility	Are chemicals stored according to compatibility?	Store Chemicals by hazard class. (e.g.: flammable/acids/bases/oxidizers)
		Secondary container use	Are secondary containers used to transport chemicals outside the lab?	Use secondary containers (trays, coolers, etc) to transport chemicals outside the laboratory.
		Secondary containment	Is secondary containment used to store hazardous waste?	Chemicals placed in hazardous waste accumulation area shall be stored in secondary containers to contain leaks/spills.
		Chemical inventory	Is laboratory chemical inventory available and up-to-date?	Develop and maintain a chemical inventory. Chemical inventories assist emergency response teams with incident management. Inventories also minimize the volume/number of chemicals in the laboratory by.
		Training documentation	Is training up-to-date and is documentation maintained for each laboratory PI/worker? Are training records available for each person in the laboratory	Document initial and annual Basic Laboratory Safety training and place in your training binder. Basic Laboratory Safety training is available through RMS or via Open WebCT. For a sample training documentation form, refer to the RMS/Laboratory Safety webpage. (www.auburn.edu/rms) Training records shall be maintained in the lab and available upon request.
		Gas cylinders	Are gas cylinders properly marked, stored/secured (chained, strapped, etc)?	Cylinders of compressed gases(full or empty) should be properly fastened and supported be straps, belts, buckles, or chains to prevent them from falling and causing bodily harm or facility damage.
		Compressed gas storage	Is the lab in compliance with NFPA standards for compressed gas storage (maximum number of cylinders/area by sf, types of gases)	Labs not equipped with sprinkler system- no more than 9 full-size gas cylinders allowed per 500sf to include no more than 3 oxidizers or flammable cylinders.

Status		C/A Description	Question	Corrective Action
YES	NO			
		Gas cylinder(s) secured	Are gas cylinders capped, collared, or tapped with regulator?	When not in use, gas cylinders shall be capped or collared.
		Sharps disposal	Are sharps disposed of properly?	Reinforce policy- Needles shall not be bent, sheared, broken, recapped, removed from disposable syringes, or otherwise manipulated by hand before disposal. They must be placed in conveniently located puncture-resistant containers used for sharps disposal. For specific information on proper disposal of sharps, refer to the AU Medical Waste Management Guide located on the RMS/Biosafety webpage. (www.auburn.edu/rms)
		Broken glassware	Are provisions in place for disposal of broken glassware?	Provide laboratory with broom and dustpan as a mechanical means for disposal of broken glassware. Purchase broken glass containers or you may use cardboard boxes lined with puncture resistant bags. Once containers are taped and marked clearly as “Broken Glass”, they can be disposed of as solid waste. For more information, refer to RMS/Laboratory Safety webpage. (www.auburn.edu/rms)
		Waste management	Is the AU Medical Waste Management Guide available in the lab? Are lab PI/Workers documenting annual reviews of this guide and training on proper procedures for disposal of medical waste?	Maintain a copy of the AU Medical Waste Management Guide in the laboratory. Document annual review/training on location, use and content of Medical Waste Management Guide. For a sample training documentation form, refer to the RMS/Laboratory Safety webpage. (www.auburn.edu/rms) Training records shall be maintained in the lab and available upon request.
		Pipette tips	Are pipette tips disposed of properly?	Contaminated pipette tips shall be disposed of as regulated medical waste and placed in an appropriate sharps container. Non-contaminated pipettes tips shall be disposed of as solid waste. RMS recommends that non-contaminated pipette tips be placed in a sturdy container (e.g.: milk jug, coffee can, etc.) prior to disposal.

Status		C/A Description	Question	Corrective Action
YES	NO			
		Waste accumulation site	Is the waste accumulation site in an appropriate area and clearly marked?	Place “Hazardous Waste Accumulation Area” sign at or near the area where hazardous waste is accumulated. Fume hoods shall not be used as a waste accumulation area.
		Electrical/ extension cords	Are all electrical cords in good condition? Is the policy of no extension cords being followed?	Replace worn cords to prevent electrical shock and/or fire. Do not use extension cords as a permanent electrical source.
		CFCI	Are Ground Fault Circuit Interrupters (GFCIs) installed in wet or high humidity areas?	Place work order with facilities to install GFCI in wet areas. Contact RMS for assistance if required.
		BSM	Is the AU Biological Safety Manual available in the lab? Are PIs/workers documenting initial and annual reviews of this manual, its location/use/content?	Document initial and annual reviews of the Biological Safety Manual, its location, use, content. Place a form/log, for initial and annual reviews, in the front of your AU Biological Safety Manual so that it is readily available during audits.
		Biosafety training	Is initial and annual biosafety training documented?	Document initial and annual biosafety training and place in your training binder. Biosafety training is available through RMS or via Open WebCT. Training records shall be maintained in the lab and available upon request.
		Lab specific	Is lab specific training documented?	Document lab specific training. Suggestion: Provide a list of lab specific training items/topics on a single sheet of paper placed with your training documentation form, simply record “Lab Specific Training” completed. For a sample training documentation form, refer to the RMS/Laboratory Safety webpage. Training records should be maintained in the lab and available upon request.
		LSM	Is a copy of the Laboratory Safety Manual available?	Maintain a copy of the Laboratory Safety Manual in each laboratory. For a copy of the manual, refer to the RMS/Laboratory Safety webpage. (www.auburn.edu/rms)
		SOP	Are laboratory specific Standard Operating Procedures (SOP) available?	Develop laboratory specific Standard Operating Procedures (SOPs) for your laboratory operations. Laboratory personnel shall be trained on these procedures as applicable.

Status		C/A Description	Question	Corrective Action
YES	NO			
		MSDS	Are MSDSs available, updated, and accessible 24/7?	Maintain a MSDS booklet for all chemicals and other hazardous substances used in laboratory area.
		Exposure Control Plan	For Lab AT RISK FOR BLOODBORNE PATHOGEN EXPOSURE: Is the AU Exposure Control Plan available in the lab and is initial and annual reviews documented?	Document initial and annual review of AU Exposure Control Plan. Place a form/log, for initial and annual reviews, in the front of your AU Exposure Control Plan so that it is available upon request. For a sample training documentation form, refer to the RMS/Laboratory Safety webpage. (www.auburn.edu/rms)
		BBP training	FOR LABS AT RISK FOR BLOODBORNE PATHOGEN EXPOSURE: Is initial and annual bloodborne pathogen training documented?	Document initial and annual bloodborne pathogen training and place in your training binder. Bloodborne pathogen training is available through RMS or via Open WebCT. Training records shall be maintained in the lab and available upon request.
		Vaccinations	FOR LABS AT RISK FOR BLOOODORNE PATHOGENS EXPOSURE: Is Hepatitis B vaccination consent/declination form available?	Maintain a copy of the Hepatitis B vaccination consent/declination form in the laboratory for review during audits. For further guidelines and for access to the required form, refer to the AU Exposure Control Plan located on the RMS/Biosafety webpage. (www.auburn.edu/rms)

Appendix 2
Example Chemical Inventory Form

Appendix 3
Training Form

Risk Management and Safety Training Documentation Form

<i>This Table Is For Identification Purposes Only</i>	
Printed Trainee Name: (Last, First, Middle Initial)	Initials:
Printed Principal Investigator (PI)/Trainer Name: (Last, First, Middle Initial)	Initials:
Printed Trainer Name: (Last, First, Middle Initial)	Initials:
Printed Trainer Name: (Last, First, Middle Initial)	Initials:

<i>This Table Is For Training Documentation Purposes</i>			
Recommended Laboratory Safety Training	Training Date	Trainee Initials	PI/Trainer Initials
Basic Laboratory Safety			
Chemical/Medical Waste Management			
Emergency Response			
Laboratory Specific Training (Corrosives, flammables, explosives, unstable chemicals, carcinogenics, mutagenics, teratogenics, compressed gases, human blood/blood products, radioactive materials)			
Training Conducted	Training Date	Trainee Initials	PI/Trainer Initials
Recommended Biosafety Training			
Biosafety Training			
Bloodborne Pathogens			
Human Infectious Agents			
Biological Agent Specific			
Recombinant DNA			

I have been trained on and/or read and understood the above mentioned items. I understand it is my responsibility to comply with the Auburn University Lab Safety Manual and Biosafety Manual and all other University policies and procedures. I will request additional information whenever I am unsure of a process or procedure and I will do so before proceeding.

Employee signature: _____ **Date:** _____

Appendix 4

Incompatible Chemicals

Chemical	Incompatible With
Acetic Acid	Nitric acid, chromic acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates
Acetic anhydride	Hydroxyl-containing compounds such as ethylene glycol, perchloric acid
Acetone	Concentrated nitric and sulfuric acid mixtures, hydrogen peroxide
Acetylene	Chlorine, bromine, copper, fluorine, silver, mercury
Alkali and alkaline earth metals, such as sodium potassium, lithium, magnesium, calcium, powdered aluminum	Carbon dioxide, carbon tetrachloride, other chlorinated hydrocarbons (also prohibit the use of water, foam, and dry chemical extinguishers on fires involving these metals-dry sand should be employed)
Ammonia, Anhydrous	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or combustible materials
Aniline	Nitric acid, hydrogen peroxide
Bromine	Same as chlorine: ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Butyl lithium	Water
Calcium oxide	Water
Carbon, activated	Calcium hypochlorite, all oxidizing agents
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organic or combustible material
Chromic Acid	Naphthalene, camphor, glycerol, acetic acid, turpentine, alcohol, flammable liquids in general
Chlorine	Same as bromine: ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Cumene hydroperoxide	Acids, organic or inorganic
Cyanides (NA, K)	Acids
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, other oxidizing agents and halogens
Fluorine	Isolate from everything

Chemical	Incompatible With
Hydrazine	Hydrogen peroxide, nitric acid, any other oxidant
Hydrocarbon (benzene, butane, propane, gasoline, turpentine, etc.)	Fluorine, chlorine, bromine, chromic acid, peroxides
Hydrocyanic acid	Nitric acid, alkalis
Hydrofluoric acid(anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, any flammable liquid, combustible materials, aniline, nitromethane
Hydrogen sulfide	Fuming nitric acid oxidizing gases
Iodine	Acetylene, ammonia (aqueous or anhydrous), hydrogen
Mercury	Acetylene, fulminic acid, ammonia
Nitroparaffins	Inorganic bases, amines
Nitric Acid	Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, acetone, nitratable substances, flammable gases
Oxalic acid	Silver, mercury
Oxygen	Oils, grease, hydrogen, flammable liquids, solids, gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, sulfuric acid, organics
Peroxides, organic	Acids (organic or mineral), (also avoid friction, store cold)
Phosphorous (white)	Air, oxygen
Phosphorus pentoxide	Alcohols, strong bases, water
Potassium perchlorate	Acids (see also perchloric acid)
Potassium	Carbon tetrachloride, carbon dioxide, water
Potassium chlorate	Acids (see also chlorates)
Potassium permanganate	Glycerin, ethylene glycol, benzaldehyde, sulfuric acid
Silver and silver salts	Glycerin, ethylene glycol, benzaldehyde, sulfuric acid, acetylene, oxalic acid, tartaric acid, ammonium compounds
Sodium	Carbon tetrachloride, carbon dioxide, water, see alkali metals
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (or compound similar light metals, such as sodium, lithium, etc.)

Appendix 5 Carcinogens

Examples of Select Carcinogens

2-Acetylaminofluorene	Dimethyl sulfate
Acrylamide	Ethylene dibromide
Acrylonitrile	Ethylene oxide
Aflatoxins	Ethylenimine
4-Aminobiphenyl	Formaldehyde
Arsenic and certain arsenic compounds	Hexamethylphosphoramide
Asbestos	Hydrazine
Azathioprine	Melphalan
Barium chromate	4,4'-Methylene-bis[2-chloroaniline]
benzene	Mustard gas (bis(2-chloroethyl)sulfide)
Benzidine	N,N-Bis(2-chloroethyl)-2-naphtylamine (chlornaphazine)
Bis (chloromethyl) ether	<i>alpha</i> -Naphthylamine
1,4-Butanediol dimethylsulfonate (myleran)	<i>beta</i> -Naphthylamine
Chlorambucil	Nickel carbonyl
Chloromethyl methyl ether	4-Nitrobiphenyl
Chromium and certain chromium compounds	N-Nitrosodimethylamine
Cyclophosphamide	<i>beta</i> -Propiolactone oxide
1,2-Dibromo-3-chloropropane	Thorium dioxide
3,3'-Dichlorobenzidine (and its salts)	Treosulfan
Diethylstilbestrol	Vinyl chloride
4-Dimethylaminoazobenze	

Appendix 6

Peroxide Formers

Classes of Peroxidizable Chemicals

Chemicals that form explosive levels of peroxides without concentration			
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Butadiene ^a	Divinylacetylene	Tetrafluoroethylene ^a	Vinylidene chloride
Chloroprene ^a	Isopropyl ether		

Chemicals that form explosive levels of peroxides on concentration (note: may occur through evaporation)			
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Acetal	Diacetylene	3-Methyl-1-butanol	Tetrahydrofuran
Acetaldehyde	Dicyclopentadine	Methylcyclopentane	Tetrahydronaphthalene
Benzyl alcohol	Diethyl ether	Methyl isobutyl ketone	Vinyl ethers
2-Butanol	Diethylene glycol dimethyl ether (diglyme)	4-Methyl-2-pentanol	Other secondary alcohols
Cumene	Dioxanes	2-pentanol	
Cyclohexanol	Ethylene glycol dimethyl ether (glyme)	4-Penten-1-ol	
2-Cyclohexen-1-ol	4-Heptanol	1-Phenylethanol	
Cyclohexene	2-Hexanol	2-Phenylethanol	
Decahydronaphthalene	Methylacetylene	2-Propanol	

Chemical that may autopolymerize as result of peroxide accumulation			
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Acrylic acid ^b	Chlorotrifluoroethylene	Vinyl acetate	Vinylidene chloride
Acrylonitrile ^b	Methyl methacrylate ^b	Vinylacetylene	
Butadiene ^c	Styrene	Vinyl chloride	
Chloroprene	Tetrafluoroethylene ^c	Vinylpyridine	

Classes of Peroxidizable Chemicals

Chemicals that may form peroxides but cannot clearly be placed in sections A-C			
Acrolein	<i>n</i> -Butyl phenyl ether	Di- <i>n</i> -propoxynethane ^d	<i>n</i> -Methylpenetole
Allyl ether ^d	<i>n</i> -Butyl vinyl ether	1-2-Epoxy-3-isopropoxy propane ^d -	2-Methyltetrahydrofuran
Allyl ethyl ether	Chloroacetaldehyde diethylacetal ^d	1,2-Epoxy-3-phenoxy propane	3-Methoxy-1-butyl acetate
Allyl phenyl ether	2-Chlorobutadiene	<i>p</i> -Ethoxyacetophenone	3-Methoxyethyl acetate
<i>p</i> -(<i>n</i> -Amyloxy) benzoyl chloride	1-(2-Chloroethoxy)-2-phenoxyethane	1-(2-Ethoxyethoxy) ethyl acetate	2-Methoxyethyl vinyl ether
<i>n</i> -Amyl ether	Chloroethylene	2-Ethoxyethyl acetate	Methoxy-1,3,5,7-cycloocta tetraene
Benzyl <i>n</i> -butyl ether ^d	Chloromethyl methyl ether ^e	(2-Ethoxyethyl)- <i>o</i> -benzoyl benzoate	<i>beta</i> -Methoxypropionitrile
Benzyl ether ^d	<i>b</i> -Chlorophenetole	3-Ethoxypropionitrile	<i>m</i> -Nitrophenetole
Benzyl ethyl ether ^d	<i>o</i> -Chlorophenetole	2-Ethylacryldehyde oxime	1-Octene
Benzyl methyl ether	<i>p</i> -Chlorophenetole	2-Ethylbutanol	Oxybis(2-ethyl acetate)
Benzyl 1-naphthyl ether ^d	Cyclooctene ^d	Ethyl <i>beta</i> -ethoxypropionate	Oxybis(2-ethyl benzoate)
1,2-Bis(2-chloroethoxy) ethane	Cyclopropyl methyl ether	2-Ethylhexanal	<i>beta</i> , <i>beta</i> -Oxydipropionitrile
Bis(2 ethoxyethyl) ether	Diallyl ether ^d	Ethyl vinyl ether	1-Pentene
Bis(2-(methoxyethoxy) ethyl ether	<i>p</i> -Di- <i>n</i> -butoxybenzene	Furan	Phenoxyacetyl chloride
Bis(2-chloroethyl) ether	1,2-Dibenzoyloxyethane ^d	2,5-Hexadiyn-1-ol	<i>alpha</i> -Phenoxypropionyl chloride
Bis(2-ethoxyethyl) adipate	<i>p</i> -Dibenzoyloxybenzene ^d	4,5-Hexadien-2-yn-1-ol	Phenyl <i>o</i> -propyl ether
Bis(2-ethoxyethyl) phthalate	1,2-Dichloroethyl ethyl ether	<i>n</i> -Hexyl ether	<i>p</i> -Phenylphenetone
Bis(2-methoxyethyl) carbonate	2,4-Dichlorophenetole	<i>p,o</i> -Iodophenetole	<i>n</i> -Propyl ether
Bis(2-methoxyethyl) ether	Diethoxymethane ^d	Isoamyl benzyl ether ^d	<i>n</i> -Propyl isopropyl ether
Bis(2-methoxyethyl) phthalate	2,2-Diethoxypropane	Isoamyl ether ^d	Sodium 8,11,14-eicosatetraenoate
Bis(2-methoxymethyl) adipate	Diethyl ethoxymethylenemalonate	Isobutyl vinyl ether	Sodium ethoxyacetylid ^f
Bis(2- <i>n</i> -butoxyethyl) phthalate	Diethyl fumarate ^d	Isophorone ^d	Tetrahydropyran
Bis(2-phenoxyethyl) ether	Diethyl acetal ^d	<i>beta</i> -isopropoxypropionitrile ^d	Triethylene glycol diacetate
Bis(4-chlorobuyl) ether	Diethylketene ^f	Isopropyl 2,4,5-trichloro-phenoxyacetaet	Triethylene glycol dipropionate -
Bis(chloromethyl) ether ^e	<i>m,o,p</i> -Diethoxybenzene	Limonene	1,3,3-Trimethoxypropene ^d
	1,2-Diethoxyethane	1,5- <i>p</i> -Methadiene	

2-Bromomethyl ethyl ether	Dimethoxymethane ^d	Methyl- <i>p</i> -(<i>n</i> -amyloxy) benzoate	1,1,2,3-Tetrachloro-1,3-butadiene -
<i>beta</i> -Bromophenetole	1,1-Dimethoxyethane ^d	4-Methyl-2-pentanone	4-Vinyl cyclohexene
<i>o</i> -Bromophenetole	Dimethylketene ^f	<i>n</i> -Methylpenetole	Vinylene carbonate
<i>p</i> -Bromophenetole	3,3-Dimethoxypropene		Vinylidene chloride ^d
3-Bromopropyl phenyl ether	2,4-Dinitrophenetole		
1,3-Butadiyne	3,3-Dioxepane ^d		
Buten-3-yne	Di(1-propynyl) ether ^f		
<i>tert</i> -Butyl ethyl ether	Di(2-propynyl) ether		
<i>tert</i> -Butyl methyl ether			

Classes of Peroxidizable Chemicals

SAFE STORAGE PERIOD FOR PEROXIDE FORMERS	
Description	Period
Unopened chemicals from manufacturer	18 months
Opened containers	
Chemicals in Part A, Table 1	3 months
Chemicals in Part B and D, Table 1	12 months
Uninhibited chemicals in Part C, Table 1	24 hours
Inhibited chemicals in Part C, Table 1	12 months ^b

^b Do not store under inert atmosphere, oxygen required for inhibitor to function.

Source: Kelly, Richard J., Chemical Health and Safety, American Chemical Society, 1996, Sept, 28-36, Rev. 12/97.