



Coweeta Hydrologic Laboratory Lab Safety Manual

(Chemical Hygiene Plan)

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1.0 OVERVIEW

1.1 OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION REQUIREMENTS

As part of continuing efforts to provide a safe and healthful work place for any person working in or visiting the Analytical Lab, Coweeta Hydrologic Laboratory 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 employees, visitors, and the institution. It makes good sense and good science.

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 to meet the medical consultation and examination requirements and
- Emergency Procedures.

1.2 OBJECTIVES – The primary goal of this program is to set standards which ensure the safety of all persons working in or visiting the analytical lab. To accomplish this, Coweeta Hydrologic Laboratory is committed to achieving the following goals:

- Maintain a safe environment for anyone working in the lab, 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.

1.3 RESPONSIBILITY FOR SAFETY

Responsibility for laboratory safety and chemical hygiene in the laboratory rests with the Laboratory Manager and with the Project Leader. The Project Leader has the ultimate responsibility to ensure the protection of the health and safety of its employees, students, and visitors in the analytical lab.

Chemical Hygiene Officer

The Laboratory Manager will serve as the Chemical Hygiene Officer (CHO). The CHO is a key component of the LSM. The CHO monitors the LSM 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 disposal of chemicals used in the laboratory;
- 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 Manager

The Laboratory Manager 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](#), Coweeta Hydrologic Laboratory Analytical Laboratory Inspection Form.
- Maintain a proper inventory and storage of the chemicals by utilizing the Chemical Inventory form found in [Appendix 2](#), and the information provided in [Appendix 4](#) Incompatible Chemicals, and [Appendix 6](#) 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 5](#) 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 3](#), Laboratory Safety Protocol Form.
- 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 Manager's responsibility to ensure the safety of all visitors in the laboratory. All visitors including repairman, service technicians and inspectors must check in with the laboratory manager.

2.0 Chemical Hygiene Plan

2.1 OVERVIEW

This LSM addresses employees at Coweeta. 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. The success of this program will depend on the development and/or implementation of the following information:

- Chemical inventories for the laboratory and storage area.
- Material Safety Data Sheet (MSDS) files for the laboratory.
- Standard Operating Procedures for specific hazardous chemicals used in the laboratory.
- 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.
- Accurate and up-to-date recordkeeping as required by the LSM.
- Designation of a safety committee or officer to develop and help implement safety procedures and meet requirements of the LSM.

2.2 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 the 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. The Laboratory Manager 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 Manager.

2.2a Chemical Procurement

All laboratory employees involved in the receiving of chemicals should be informed about proper handling, storage, and disposal procedures. The lab manager should be notified of all chemical purchases. 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.

2.2b 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 Laboratory Manager.
- 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 work alone in the lab.
- 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 Manager.
- 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 Manager.
- 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 Manager. An 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.

2.2c 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 the 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.

2.2d 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. The lab manager should be informed and the incident logged.
- 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 located in labs are not for food storage. Refrigerator in kitchen area is for food storage only and must not be used to store chemicals. Lab refrigerators must have signs posted prohibiting food storage. Kitchen refrigerator must have signs stating food only.

2.2e 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 skirts when working in the laboratory. Wear long pants.
- 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.

2.2f 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 the broken glass 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.

2.2g Prior Approval

Employees must obtain prior approval from the Laboratory Manager, 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.

2.2h Chemical Spills

Spills of chemical substances should be resolved immediately by use of chemical spill kits. See [APPENDIX 7](#) for methods of clean up for chemical spills.

2.3 SPECIFIC SAFETY PROCEDURES

Applicable precautions described in this manual should be used for all procedures performed in the lab. Precautions specific to established methods are listed in each method found in the Coweeta Analytical Lab Cookbook. The cookbook can be found on the Forest Service website <http://www.srs.fs.usda.gov/coweeta/data/>

Each person intending to work in the lab should read and understand these practices before commencing a procedure.

2.3a 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 Manager 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 - https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10100](https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10100)) 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 2.1

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

2.3b 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.

2.3c 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 CFR 1361.23;
- 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 are 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.

2.3d 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 5](#) and the [National Toxicology Program](#) , http://ntpsearch.niehs.nih.gov/texis/search/?pr=ntp_web_entire_site_all&mu=Testing+Status 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.

2.4 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 Manager 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.

2.4a 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, and the vaneometer indicates no air movement is occurring through the hood or the user detects chemical odors coming out of the hood. The laboratory manager 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.

2.4b 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.

2.4 c 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.

2.4d Respirators

Respirators may not be used under any circumstance unless approved by the Safety Officer.

2.5 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 \(for federal employees - SHIPS, and for University of Georgia employees - see supervisor and follow procedures outlined in Human Resources\)](#).
- 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 Manager 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.

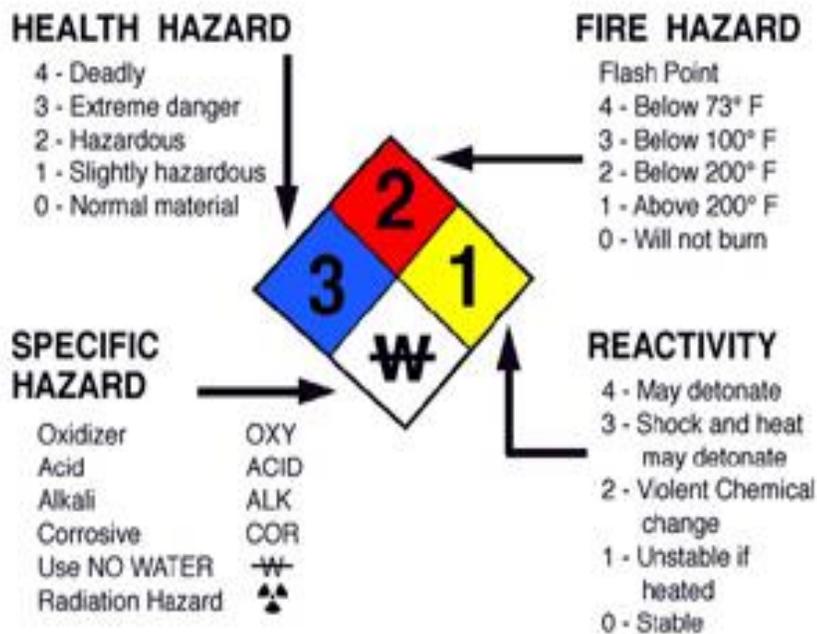
The employee's supervisor must obtain a written opinion from the physician performing the examination or consultation, which must include the following:

- 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

3.1 GENERAL INFORMATION ABOUT CHEMICALS

Coweeta Hydrologic Laboratory follows the 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 firefighting personnel and others who may be exposed.
3. A means of identifying hazardous materials and areas in which they are stored for anyone working in the lab.

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 greater the hazard.

3.1a Material Safety Data Sheets

Anyone working in the lab should have access to the MSDS at all times. The MSDS notebook for the Analytical Lab (AL) is located in the hallway of the AL. The MSDS are filed alphabetically. The MSDS is updated as new sheets are received. 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 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 Manager.

3.1b Obtaining/Maintenance of MSDS

Prior to ordering a chemical an MSDS should be obtained by the laboratory manager, 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.

3.2 CHEMICAL LABELING

3.2a 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 be labeled with the date received and the responsible party's initials.

3.2b 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.

3.3 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.

3.3a 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 6](#).

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.

3.4 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.

3.4a 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.

3.4b Inventory

Proper inventory control is essential in the laboratory. The laboratory manager is required to keep an inventory ([Appendix 3](#)) of chemical.

Subsequent receipt of chemicals must be dated 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.

3.4c 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 and stored in the gas cylinder storage cage. 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.

3.5 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 Manager 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.

Pipetting of liquids should be performed using a laboratory safety pipette bulb or pump. Automatic burettes 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. Before moving chemicals in or out of the building, the laboratory worker should ensure the way is clear.

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.

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.

3.6 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. 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 the gas cylinder cage. If a leaking cylinder is discovered, move it to a safe place (if it is safe to do so) and inform the lab manager. The lab manager will 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 gas cage storage area to be picked up 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.

3.7 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. See the appropriate JHA for handling liquid from a Dewar.

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 warms and becomes 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).

4.0 LABORATORY EQUIPMENT

4.1 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 Manager 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.

4.2 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 Manager 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).

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 water baths. 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.
- 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 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.

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 manager in accordance with the procedures outlined in the operating manual.

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 the laboratory manager informed immediately 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 from the Laboratory Manager.

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 Manager can answer any questions about the proper use of instruments.

Fire Extinguishers

The Safety Officer is responsible for the procurement, placement, inspection, and maintenance of all fire extinguishers at Coweeta.

Laboratory personnel should be adequately trained regarding pertinent fire hazards associated with their work. This training can be provided by contacting the Coweeta Safety Officer.

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-based 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 contact the Safety Officer 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, the Laboratory Manager can provide appropriate instruction.

5.1 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 section 6, 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.

5.2 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.

5.3 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 Laboratory Manager 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 the Safety Officer and the wearer has been certified. This program includes a physical evaluation, fit testing and training. If a respirator is thought to be needed, please call the Safety Officer and request a hazard assessment to determine if one is required.

6.0 MANDATORY SAFETY EQUIPMENT

6.1 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.

6.1a 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 monthly to flush the line and to verify proper operation.

6.1b 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 monthly (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.

6.1c 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.

6.1d 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.

6.1e 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.

6.1f Spill Cleanup 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

7.0. VENTILATION

7.1 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.

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 Coweeta.

7.2 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 a qualified technician 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.

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. Contact the Lab Manager if a project requires equipment to be left in a hood for an extended period of time.

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 the lab manager 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 certified technician will be called in to repair the hood. A red tagged hood cannot be used until it has been repaired.

8.0 LABORATORY WASTE

DISPOSAL OF CHEMICAL WASTES

Federal 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.

8.1 Hazardous Waste Disposal

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: Examples include heavy metals and many organic compounds.

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.

In accordance with the Coweeta Hydrologic Laboratory 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

Chemical waste is stored in the chemical storage building. The location is determined by the compatibility of the waste with other chemicals stored in the building. The lab manager makes this determination. The lab manager arranges for a waste disposal company to pick up and dispose of the waste yearly. The waste disposal company must be a registered and certified company in waste disposal.

8.2 PROCEDURE FOR LABORATORY CLOSEOUT (VISITORS WORKING IN THE LAB)

Proper disposition of all hazardous materials used in laboratories is the responsibility of the principal investigator or researcher to whom a laboratory space is assigned. Ultimate responsibility for hazardous materials management lies with the lab manager. Therefore when space is allocated to a visiting student or PI a procedure for waste disposal is agreed upon. Allowing visiting students and PI's to work in the Coweeta Analytical Lab is a privilege that should not be taken for granted.

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. Chemical wastes must not be placed in the sanitary sewer or trash; they must be collected for disposal.

9.0 EMERGENCY/INCIDENT PROCEDURES

All emergencies or incidents in the lab (fire, major chemical spill, and explosive chemical) must be immediately reported to the Lab Manager.

9.1 INCIDENT RESPONSE PROCEDURES

Upon notification of an emergency or incident (fire, chemical spill, and explosive chemical) the lab manager will contact the project leader and safety officer.

Fire Evacuation Procedures

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

- Shout "FIRE".
- Evacuate the area.
- Call 911. Give specific information, such as building name. Arrange for someone to meet the fire fighters outside the building.
- Close doors to help control spread of smoke and fire.

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.

Chemical Spills

The type of spill defines what action to take. See Appendix 7 for a detailed description of handling a chemical spill. The following defines what response to take.

- Simple Spill: Determine if the laboratory has the proper material; e.g. absorbents and containers, to commence cleanup.
- Complicated Spill: Occupants should evacuate immediately and contact the lab manager. 911 personnel will be notified. 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. The project leader and safety officer will be contacted.

In the event of any major spill, 911 are to be contacted. The project leader and safety officer will be contacted.

Explosive Chemicals

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

- Inspect the suspect material. Determine hazard potential.
- If determined that explosive potential exists and the material must be removed:
 - Contact the SRS Safety and Environmental Manager, Mike Alcorn telephone 828-259-0541 (office) or 828-772-0535 (cell) who will provide guidance and locate an independent contractor who is licensed to remove and dispose of explosive materials.

10.0 APPENDIX

Appendix 1

Lab Inspection Form

1. Is the Coweeta Hydrologic Laboratory Emergency Contact list posted?
2. Refrigerators, microwaves, ice machines, incubators, etc. shall be marked with “No Food or Drink” signs.
3. Refrigerators used for storing human food shall be marked with “Human Food Only” sign.
4. Radiation Hazards - Are radioactive materials/radiation work area(s)/equipment /other radiation hazards properly labeled
5. Eyewash stations shall be inspected weekly by laboratory workers and documented on a log and posted at or near the eyewash station
6. Is Personal Protective Equipment (PPE) available and appropriate?
7. Is a First Aid Kit available/maintained?
8. Is autoclave use log available / current, and are autoclaves tested after 40 hours of combined operation?
9. Are Fume hoods certified?
10. Is equipment, supplies, and/or chemicals used inside the fume hood appropriately positioned?
11. Are chemicals dated and initialed upon opening?
12. Are all chemical storage areas adequately identified?
13. Are all liquid chemicals stored below eye-level?
14. Flammable storage - Are all flammables stored appropriately?
15. Are highly reactive chemicals stored in chemical-safe refrigerators?
16. Are chemicals stored according to compatibility?
17. Is secondary containment used to store hazardous waste?
18. Is training up-to-date and is documentation maintained for each laboratory PI/worker?

19. Gas cylinders - Are gas cylinders properly marked, stored/secured (chained, strapped, etc.)?

20. Is the lab in compliance with NFPA standards for compressed gas storage (maximum number of cylinders/area by sf, types of gases). No more than 9 full-size gas cylinders allowed per 500sf to include no more than 3 oxidizers or flammable cylinders.

21. Are gas cylinders capped, collared, or tapped with regulator?

22. Sharps disposal -Are sharps disposed of properly?

23. 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.

24. Is a copy of the Laboratory Safety Manual available?
Maintain a copy of the Laboratory Safety Manual in the lab.

25. Are MSDSs available, updated, and accessible 24/7?
Maintain a MSDS booklet for all chemicals and other hazardous substances used in laboratory area.

Appendix 2
Example Chemical Inventory Form

Chemical Inventory

CHEMICAL NAME	MANUFACTURER	DATE RECEIVED	QUANTITY
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Appendix 3

Laboratory Safety Protocol Form

I have been given a copy of the Laboratory Safety Protocol and was instructed on laboratory safety which includes but is not limited to eye wash and safety shower stations. I understand it is my responsibility to comply with the Coweeta Hydrologic Laboratory Lab Safety Manual which is located in the analytical lab hallway. 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	Is Incompatible with
Acetic acid	Chromic acid, nitric acid alcohols, ethylene glycol, perchloric acid, peroxides, permanganates
Acetone	Concentrated nitric and sulfuric acid mixtures
Acetylene	Chlorine, bromine, fluorine, copper, silver, mercury
Acids	Bases
Activated Carbon	Calcium hypochlorite, oxidizing agents
Alkali Metals	Water, carbon tetrachloride and other halogenated alkanes, carbon dioxide, halogens
Aluminum Alkyls	Water
Ammonia,	Mercury (e.g., in pressure gauges), laboratory gas chlorine, calcium hypochlorite, iodine, bromine, hydrogen fluoride
Ammonium	Acids, powdered metals, flammable liquids, chlorates, nitrates, sulfur, fine-particulate organic Nitrate or combustible materials.
Aniline	Nitric acid, hydrogen peroxide
Azides	Acids
Bases	Acids
Bromine	See chlorine
Carbon Tetrachloride	Sodium
Chlorates	Ammonium salts, acids, powdered metals, sulfur, fine-particulate organic or combustible substances
Chlorine	Ammonia, acetylene, butadiene, butane, methane, propane, hydrogen, petroleum benzine, benzene, powdered metals
Chromic Acid	Acetic acid, naphthalene, camphor, glycerol, petroleum benzine, alcohols, flammable liquids
Copper	Acetylene, hydrogen peroxide
Cumene Hydroperoxide	Acids, both organic and inorganic
Cyanides	Acids
Flammable Liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	Store separately

Hydrocarbons (butane, propane, benzene, etc.)	Fluorine, chlorine, bromine, chromic acid, sodium peroxide
Hydrogen Fluoride	Ammonia, laboratory gas or solution
Hydrogen Peroxide	Copper, Chromium, iron, metals and metals salts, alcohols, acetone, organic substances, aniline, nitromethane, combustibles (solid or liquid)
Hydrogen Sulfide	Fuming nitric acid, oxidizing gases
Iodine	Acetylene, ammonia (laboratory gas or solution)
Mercury	Acetylene, ammonia
Nitric Acid, Conc.	Acetic acid, aniline, chromic acid, prussic acid, hydrogen sulfide, flammable liquids and gases
Oxalic Acid	Silver, mercury
Perchloric Acid	Acetic anhydride, bismuth and its alloys, alcohols, paper, wood
Phosphorus	Sulfur, oxygen-containing compounds with such as chlorates
Potassium	See alkali metals
Potassium Chlorate	See chlorates
Potassium Perchlorate	See chlorates
Potassium Permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Silver	Acetylene, oxalic acid, tartaric acid, ammonium compounds.
Sodium	See alkali metals
Sodium Peroxide	Methanol, ethanol, glacial acetic acid, anhydride, benzaldehyde, carbon disulfide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfides	Acids
Sulfuric Acid	Potassium chlorate, potassium perchlorate, potassium permanganate

Please note: This is not an exhaustive list of incompatible chemicals. See the specific lab standard operating procedures or your Lab Manager to determine additional material incompatibilities of which to be aware.

Appendix 5

Carcinogens

Examples of Select Carcinogens

- Asbestos
- Vinyl chloride
- 4-nitrobiphenyl
- Inorganic arsenic
- Alpha-naphthylamine
- Ethylene oxide
- Methyl chloromethyl ether
- 1,2-Dibromo-3-chloropropane (DBCP)
- 3,3'-Dichlorobenzidine
- N-nitrosodimethylamine
- Bis-chloromethyl ether
- Coal tar pitch volatiles

Appendix 6

HAZARDS OF PEROXIDES

A wide variety of organic compounds spontaneously form peroxides by a free radical reaction of the hydrocarbon with molecular oxygen. Under normal storage conditions, formed peroxides can accumulate in the chemical container and may explode when subjected to heat, friction or mechanical shock. For this reason, it is imperative that laboratories learn to recognize and safely handle peroxide-forming compounds.

PRACTICES FOR CONTROL OF PEROXIDE FORMING MATERIALS

Purchase

Ideally, purchases of peroxide-forming chemicals should be restricted to ensure that these chemicals are used up completely before they can become peroxidized. This requires careful experiment planning. Researchers should purchase no more material than is needed to complete an experiment within the chemical's safe shelf life.

Labeling and Shelf-Life Limitation

Peroxides tend to form in materials as a function of age. Therefore, it is imperative that researchers are keenly aware of the age of their peroxide-forming chemicals. Researchers must date each container upon arrival in the laboratory. Containers must be dated again when opened for the first time. An appropriate expiration date based on what type of peroxide susceptible chemical the item is should also be on the label. Track dates and dispose of items through VEHS prior to expiration.

Storage

Peroxide-forming chemicals shall be stored in sealed, air-impermeable, light-resistant containers and should be kept away from light (light can initiate peroxide formation). Peroxide-forming chemicals should be stored in their original manufacturer's container whenever possible. This is very important in the case of diethyl ether because the iron in the steel containers that the material is shipped in acts as a peroxide inhibitor.

Inhibitors

Many methods can be used to stabilize or inhibit the peroxidation of susceptible chemicals. If it does not interfere with the use of the chemical and if available, peroxide-forming chemicals shall be ordered with inhibitor added and peroxide scavengers (inhibitors) shall be added in small quantities to items that have been redistilled. Contact VEHS at 322-2057 if the peroxide scavenger interferes with the use of the susceptible chemical.

Management and disposal of old containers

Older containers of peroxide-forming chemicals, or containers of unknown age or history, must be handled very carefully and should never be opened by researchers. Any peroxide-forming chemical with visible discoloration, crystallization or liquid stratification should be treated as potentially explosive. Older steel containers that have visible rust may also be extremely dangerous. If any of these conditions are observed on a peroxide-forming chemical container or if the origin and age are unknown, do not attempt to move or open the container. Contact VEHS at 2-2057 to have the container inspected and if necessary disposed of properly.

Safe Distillation of Peroxide Forming Chemicals

Eliminate the peroxides with a chemical reducing agent or pass the solvent through activated alumina.

Adding mineral oil to the distillation pot has the combined effect of “cushioning” any bumping, maintaining dilution, and serving as a viscous reaction moderator in case the peroxides begin to decompose. Carefully monitor the distillation process to ensure that it does not dry out completely, and then overheat. Distillation can concentrate peroxides, especially if taken to a dry state. Peroxides will be present mainly in the still bottoms.

Small pieces of sodium metal can be added to the distillation vessel to reduce peroxides. Use benzophenone as an indicator for the presence of sodium metal (benzophenone in the presence of sodium metal forms a radical with a deep-blue color). When the blue color disappears, add more sodium metal to the vessel.

CLASSIFICATION OF PEROXIDE FORMING MATERIALS

Chemicals that form peroxides are classified into four classes:

Class A: Peroxide Hazard on Storage – Without Concentration

These chemicals can form peroxides that are difficult to detect and eliminate. Label these items with a date of receipt and date of opening and dispose of these items 3 months after opening or 12 months if unopened.

Class B: Hazard Due to Peroxide Concentration

These chemicals can undergo explosive polymerization initiated by dissolved oxygen. Label these items with a date of receipt and date of opening and dispose of these items 6 months after opening or 12 months if unopened. When alcohols listed are used for purposes that do not involve heating, chemical reaction, bulk evaporation or other activities that may stress the peroxidizable material, it is not necessary to track and test these containers for peroxidation.

Class C: Auto Polymerize as a Result of Peroxide Accumulation

These chemicals may explode when relatively small quantities of peroxides are formed. These items normally have an inhibitor (scavenger) added to the substance by the manufacturer in order to prevent peroxides from forming. This inhibitor can be removed if it interferes with the use of the chemical or the chemical is redistilled in the lab. If a lab procedure requires the use of an uninhibited item in this Class, please contact VEHS at 322-2057. Label these items with a date of receipt and date of opening and dispose of inhibited items after 12 months and uninhibited items within 24 hours of use.

Common chemicals that form explosive levels of peroxides (this list is not inclusive)

Class A: Forms without concentration	Class B: Forms on concentration	Class C: May autopolymerize
Isopropyl ether	Acetal	Acrylic acid
Butadiene	Cumene	Butadiene
Chlorobutadiene (chloroprene)	Cyclohexene	Chlorotrifluoroethylene
Potassium amide	Diacetylene	Ethyl acrylate
Potassium metal	Dicyclopentadiene	Methyl methacrylate
Sodium amide (sodamide)	Diethylene glycol	Styrene
Divinyl acetylene	Diethyl ether	Vinyl acetate
Vinylidene chloride	Tetrahydronaphthalene	Vinyl chloride
	Dioxane	Vinyl pyridine
	Ethylene glycol dimethyl ether	Tetrafluoroethylene
	Furan	
	Cyclopentene	
	Methyl acetylene	
	Methyl cyclopentane	
	Methyl-isobutyl ketone	
	Tetrahydrofuran	
	Vinyl ethers	

R.J. Kelly, "Review of Safety Guidelines for peroxide-forming Organic Chemicals", *Chemical Health & Safety*, September/October 1996, pp 28-36.

APPENDIX 7 Chemical Spills and Accidents

General Information

Try to anticipate the types of chemical spills that can occur in your laboratory and obtain the necessary equipment (spill kits and personal protective equipment) to respond to a minor spill. Learn how to safely clean up minor spills of the chemicals you use regularly. An MSDS contains special spill clean-up information should also be consulted. **Chemical spills should only be cleaned up by trained, knowledgeable and experienced personnel.**

If the spill is too large for you to handle, requires you to put on respiratory protection, is a threat to personnel, or the public, or involves a highly toxic or reactive chemical, call for assistance immediately:

- Simple Chemical Spills - Notify the Lab Manager
- Complex Chemical Spills – The Lab Manager will call 911

Cleaning Up Chemical Spills

If you are cleaning up a small spill yourself, make sure that you are aware of the hazards associated with the materials spilled, have adequate ventilation (open windows, chemical fume hood on) and proper personal protective equipment (minimum - gloves, goggles, and lab coat). Consider all residual chemical and cleanup materials (adsorbent, gloves, etc.) as hazardous waste. Place these materials in sealed containers (plastic bags), label, and store in a chemical fume hood.

Simple Chemical Spill

- Alert people in immediate area of spill.
- Increase ventilation in area of spill (open windows, turn on hoods).
- Wear protective equipment, including safety goggles, gloves, long-sleeve lab coat and closed toe shoes.
- Avoid breathing vapors from spill.
- Use appropriate kit to neutralize and absorb inorganic acids and bases. Collect residue, place in container, and dispose as hazardous chemical waste.
- For other chemicals, use appropriate kit or absorb spill with vermiculite, dry sand, diatomaceous earth, spill pads, or paper towels. Collect residue, place in container, and dispose as chemical waste.
- Store material in a chemical fume hood temporarily while awaiting chemical waste pickup.
- Clean spill area with water.

Complex Chemical Spill

- Attend to injured or contaminated persons and remove them from exposure.
- Alert people in the laboratory to evacuate.
- If spilled material is flammable, turn off ignition and heat sources. Place spill cleanup material over spill to keep substance from volatilizing.
- Call 911.
- Close doors to affected area.
- Have a person with knowledge of the incident and laboratory available to answer questions from responding emergency personnel.

Chemicals Spills on the Body

- Quickly remove all contaminated clothing and footwear.
- Get to a safety shower and immediately flood the affected body area for at least 15 minutes. Remove jewelry to facilitate removal of any residual material.
- Yell for assistance as soon as incident occurs.
- Get medical attention promptly by dialing 911. Be sure to indicate specifically what chemical was involved.

It should be noted that some chemicals (eg. phenol, aniline) are rapidly adsorbed through the skin. If a large enough area of skin is contaminated an adverse health effect (systemic toxicological reaction) may occur immediately to several hours after initial exposure depending on the chemical. In general, if more than 9 square inches of skin area has been exposed to a hazardous chemical, seek medical attention after washing the material off the skin.

Chemicals Spills on the Body – Hydrofluoric Acid (HF)

Calcium gluconate paste is an effective treatment for hydrofluoric acid exposure. Every laboratory and location where HF is used or stored should have a tube of calcium gluconate paste readily available.

In the event of an HF spill to the body:

- Immediately flood the affected body area with cool water for a minimum of 5 minutes. Apply calcium gluconate if available. If no calcium gluconate is immediately available, continue rinsing the affected area with copious amounts of water until emergency medical responders arrive. Remove contaminated clothing and footwear while rinsing.
- Call or have a co-worker call 911. Be sure to indicate that you were exposed to hydrofluoric acid.
- Gently rub calcium gluconate ointment onto the affected area. Continue applying until emergency medical responders arrive.
- Inform responders and all others that the exposure involved hydrogen fluoride/hydrofluoric acid.

Mercury Spills

- Do not use a domestic or commercial vacuum cleaner.
- Use a disposable pipette to pick up mercury droplets.
- Cover small droplets in inaccessible areas with powdered sulfur or zinc.
- Place residue in a labeled container and call the Lab Manager for disposal information.

REFERENCES

29CFR1910 Code of Federal Regulations, United States Department of Labor, OSHA.

Auburn University Risk Management and Safety, "Laboratory Safety Manual." Auburn University, 2011. Web April 2014

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R.J. Kelly, "Review of Safety Guidelines for peroxide-forming Organic Chemicals", *Chemical Health & Safety*, September/October 1996, pp 28-36.

Vanderbilt Environmental Health and Safety, "Peroxide Forming Chemicals: Management, Retention and Storage." Vanderbilt University. Web May 2014

<<http://www.safety.vanderbilt.edu/chem/peroxide-forming-chemicals.php>>