Western Carolina University | Safety and Risk Management

Chemical Hygiene Plan

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The Chemical Hygiene Plan (CHP) is intended to highlight general university wide laboratory practices that are obligatory for protecting employees from exposure to hazardous chemicals. This plan addresses all provisions of the Occupational Safety and Health Administration's (OSHA) Laboratory Standard (29 CFR 1910.1450) and is implemented by the Office of Safety and Risk Management. Each department that uses any type of hazardous material is required to have a copy of this manual readily available to personnel in the laboratory.

Definitions

Definitions for selected terms used in this policy are included below. Please see paragraph (b) of the OSHA Hazardous Chemicals in Laboratories Standard ([29 CFR 1910.1450]) for additional definitions related to the CHP.

Carcinogen – A carcinogen is any substance, radionuclide, or radiation that is an agent directly involved in causing cancer. A chemical is considered a carcinogen if:

- It has been evaluated by the International Agency for Research on Cancer (IARC), and found to be a carcinogen or potential carcinogen; or
- It is listed as a carcinogen or potential carcinogen in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or,
- It is regulated by OSHA as a carcinogen.

Chemical Hygiene Plan (CHP) – A written program developed and implemented by the Safety and Risk Management Office which sets forth work practices, procedures, equipment, and PPE that meet the requirements of 29 CFR 1910.1450 and are capable of protecting employees from the health hazards associated with hazardous chemical use.

Combustible Liquid - Combustible liquids are those liquids having a flash point at or above 100°F. Combustible liquids are divided into subclasses as follows:

Class	Flashpoint
Class II	At or above 100°F but below 140°F
Class III A	At or above 140°F but below 200°F
Class III B	At or above 200°F

Compressed Gas - A compressed gas is any mixture or material in a container with either an absolute pressure exceeding 40 psi at 70°F or an absolute pressure exceeding 104 psi at 130°F. Any liquid flammable material having a vapor pressure exceeding 40 psi at 100°F is also considered to be a compressed gas.

Corrosive – A corrosive substance is a chemical that produces destruction of skin tissue, namely, visible necrosis through the epidermis and into the dermis, in at least 1 of 3 tested animals after exposure up to a 4-hour duration. Corrosive reactions are typified by ulcers, bleeding, bloody scabs, and by the end of observation at 14 days, by discoloration due to blanching of the skin, complete areas of alopecia and scars.

Cryogens - Cryogens are gases which have been cooled to the point of liquefaction or solidification that have a boiling point below -240°F. In addition to their ability to freeze tissue, they may also present toxicity, flammability, or other hazards. Commonly used cryogens include liquid nitrogen, liquid helium, liquid argon, and solid carbon dioxide (dry ice).

Designated Area – An assigned area used to work with particularly hazardous substances. The area can be an entire laboratory, or an area or device within the lab, such as a fume hood.

Explosives – Any chemical compounds, mixtures, or devices for which the primary or common purpose is to function by explosion, i.e., with substantially instantaneous release of gas and heat.

Flammable Liquid - Flammable liquids are liquids having a flashpoint below 100°F. Flammable liquids are also known as Class I liquids and are divided into subclasses as follows:

Class	Flashpoint	Boiling Point
Class IA	Below 73°F	Below 100°F
Class IB	Below 73°F	100°F or above
Class IC	73-99°F	N/A

Health Hazard – Criteria for determining whether a chemical is classified as a health hazard are described in Appendix A of the Hazard Communication Standard (29 CFR 1910.1200). It includes chemicals that pose one of the following effects: acute toxicity (any route of exposure); skin corrosion or irritation; eye damage or irritation; sensitization to the skin or respiratory system; carcinogenicity, teratogenicity, specific organ toxicity, or aspiration hazard.

High Risk Procedure – Use of substances that require medical surveillance, exposure monitoring, vaccination, or special antidotes and operations that pose considerable risk of explosion, fire, or exposure to personnel if a malfunction were to occur (utility outage, broken container, runaway reaction, etc.). Any procedure that is likely to require engineering controls beyond those found in the standard laboratory is considered a high-risk procedure.

Highly Toxic -A chemical falling within any of the following categories:

- A chemical that has a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
- A chemical that has a median lethal dose (LD_{50}) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
- A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for one hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

Laboratory – A facility where research, testing, or scientific work is carried out. Small quantities of hazardous chemicals are utilized on a non-production basis.

Liquefied Petroleum Gas (LPG) - Any material which is composed predominately of propane, propylene, butane and butylenes, and is under sufficient pressure to maintain a liquid state.

Nanomaterials - Materials having one or more external dimensions, or an internal structure of 100 nm or less, which could exhibit novel characteristics compared to the same material without nanoscale features.

Organic Peroxides – Organic compounds that contain the bivalent -O-O-structure and which may be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizers – Chemicals other than blasting agents or explosives that initiate or promote combustion in other materials, thereby causing fire either of themselves or through the release of oxygen or other gases.

Particularly Hazardous Substances (PHSs) – select carcinogens, reproductive toxins, highly acute toxins, highly reactive substances, substances on the Department of Homeland Security's list of Chemicals of Interest and/or are included on the EPA's list of Extremely Hazardous Substances.

Physical Hazard – Criteria for determining whether a chemical is classified as a physical hazard are described in Appendix B of the Hazard Communication Standard (29 CFR 1910.1200). It includes chemicals that pose one of the following effects: flammable (gases, liquids, solids, or aerosols); oxidizer (solids, liquid, or gas); explosive; pyrophoric (solid or liquid); self-reactive; self-heating; organic peroxides; corrosive to metal; pressurized gasses; water reactive (creates flammable gas); combustible dusts.

Pyrophoric – A chemical that will ignite spontaneously in air at a temperature of 130°F (54.4°C) or below.

Reproductive Toxins – Chemicals which affect the reproductive capabilities including chromosomal damage (mutations), adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the developing fetus (teratogens).

Safety Data Sheet (SDS) – Written or printed material garnished by the producer of a hazardous chemical that details associated hazards. Must be prepared in accordance with the Hazard Communication Standard, OSHA 29 CFR 1910.1200.

Sensitizer - A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

Toxic – A chemical falling within any of the following categories:

- A chemical that has a median lethal dose (LD_{50}) of more than 50 milligrams per kilogram, but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
- A chemical that has a median lethal dose (LD_{50}) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by

continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.

- A chemical that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

Unstable (Reactive) - A chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shock, pressure or temperature.

Water Reactive - A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

Section 1: Responsibilities

Western Carolina University is committed to providing a safe and healthful environment for all persons associated with the institution, including employees, students, visitors, and the community. Cooperation of all parties involved is necessary to ensure that the University conducts research and teaching laboratories safely and in compliance with local, state, and federal regulations.

Safety and Risk Management Office

- Assist PI/Laboratory Supervisors in the selection of appropriate safety control requirements, which include laboratory practices, personal protective equipment, engineering controls, and training.
- Maintain in functional working order appropriate workplace engineering controls (e.g., fume hoods) and safety equipment (e.g. emergency showers/eyewashes, fire extinguishers), with emphasis on controls for particularly hazardous substances.
- Assist with hazard assessments and provide advice on laboratory SOPs, upon request.
- Maintain area and personal exposure-monitoring records.
- Provide technical consultation and investigation, as appropriate, for laboratory accidents and injuries.
- Assist in determining medical surveillance requirements for laboratory personnel.
- Coordinate with campus Health Services when laboratory personnel request to review their medical records. Office of Safety and Risk Management does not have access to medical records, for privacy reasons.
- Review plans for installation of engineering controls and new laboratory construction or renovation, as requested.

Chemical Hygiene Officer (CHO)

- Establish, maintain, and revise the Chemical Hygiene Plan (CHP).
- Create and revise safety rules and regulations.

- Serve on appropriate safety committees.
- Monitor procurement, use, storage, and disposal of chemicals.
- Conduct regular inspections of the laboratories, preparation rooms, and storage areas to assess compliance with the CHP and other applicable policy manuals.
- Oversee chemical inventory updates.
- Keep abreast of current legal requirements concerning regulated substances.

Department Heads

- Ensure compliance with Laboratory Safety Manuals and OSHA Hazard Communication Standard requirements for chemical safety within their respective departments.
- Ensure that proper storage areas are provided.
- Ensure timely completion of laboratory inspection reports.

Principal Investigators or Lab Supervisors

- Identify hazardous conditions or operations in the lab, determine safe procedures and controls, and implement and enforce standard safety operating procedures.
- Consult with the Safety and Risk Management Office on the use of higher risk chemicals, such as particularly hazardous substances (PHS) or highly reactive chemicals or when conducting higher risk experimental procedures so that special safety precautions may be taken.
- Maintain a chemical inventory for the laboratory.
- Provide laboratory personnel under his/her supervision with access to the CHP and all applicable SOPs and Safety Data Sheets (SDS).
- Train laboratory personnel he/she supervises to work safely with hazardous chemicals and operations and maintain records of training provided locally.
- Maintain in functional working order appropriate personal protective equipment (e.g., gloves, goggles).
- Prompt reporting of laboratory accidents and injuries to the Safety and Risk Management Office.
- Make available required medical surveillance or medical consultation/examination for laboratory personnel, if applicable.
- Inform facilities personnel, other non-laboratory, and any outside contractors of potential lab-related hazards when they are required to work in the laboratory environment. Identified potential hazards should be minimized to provide a safe environment for repairs and renovations.
- After receipt of laboratory inspection report, meets with laboratory personnel to discuss cited violations and complete the corrective actions in a timely manner to ensure that the department remains in compliance with all applicable federal, state, and local regulations.
- Ensure training of lab personnel is current and documented.
- Monitors the facilities and chemical fume hoods to ensure that they are maintained and functioning properly. Contacts Facilities Management or the Safety and Risk Management Office to report problems with the facilities or the chemical fume hoods.

Laboratory Personnel

- Read, understand, and follow the CHP and all specific laboratory safety documents.
- Follow oral and written laboratory safety rules, regulations, and standard operating procedures required for the tasks assigned.
- Follow good housekeeping and maintain the work area in a safe and uncluttered condition.
- Review and understand the hazards of materials and processes in their laboratory research prior to conducting work.
- Utilize appropriate measures to control identified hazards, including consistent and proper use of engineering controls, personal protective equipment, and administrative controls.
- Understand the purpose, capabilities, and limitations of personal protective equipment issued to them.
- Gain prior approval from the PI/Laboratory Supervisor for the use of restricted chemicals or higher risk chemicals, such as particularly hazardous substances (PHS) or conducting certain higher risk experimental procedures.
- Promptly report accidents and unsafe conditions to the PI/Laboratory Supervisor.
- Complete all required health, safety, and environmental training.
- Participate in the medical surveillance program, when required.
- Inform the PI/ Laboratory Supervisor of any work modifications ordered by a physician because of medical surveillance, an occupational injury, or exposure.

Section 2: Laboratory Registration

Every laboratory at WCU must be registered with the Safety and Risk Management Office. This process ensures that the Safety Office has a current list of occupied labs and responsible parties, a survey of the type of work being conducted in the labs, and an accurate list of lab emergency contacts.

The Principal Investigator (PI) or designated lab supervisor is required to submit a “Lab Registration Form” to initially register the space and at any time in the future if any of the following apply:

- You are relocating to a new lab space or become responsible for an additional lab space
- You are using a new hazardous material or equipment that is not identified on your current lab registration.

The Safety Office will use the information provided on the form to develop door signs for the lab. This provides a necessary reference in the event of an emergency.

Section 3: Laboratory Inspections

As required by State and Federal law, the Safety and Risk Management Office will conduct laboratory inspections to determine individual laboratory compliance with WCU’s Chemical Hygiene Plan (CHP) and other relevant safety policies. These surveys are comprehensive and address record keeping, fire safety, egress, engineering controls, personal protective equipment, work practices, and where appropriate, chemical, biological, and radiation safety. At least one annual inspection will be announced to work directly with the PI or laboratory supervisor to address specific items, such as inventories of particularly hazardous materials or processes, biosafety compliance, and any other safety concerns that arise. Other inspections may be unannounced to provide a snapshot of laboratory safety and compliance and help to continually improve the safety program.

Inspection Reports

An inspection report identifying deficiencies and areas for corrective action will be directed to the laboratory's principal investigator or supervisor. These items must be corrected within 30 days of receipt of the laboratory inspection report. If the items cannot be corrected in that timeframe, the principal investigator must submit a written corrective action plan detailing the expected corrections and estimated date of completion within the same 30 days. Any inspection finding deemed an imminent danger (likely to cause a serious hazard, injury, disability, or death) must be corrected immediately.

Lab Inspection Follow-up Process

1. If no response is received within 30 days of the initial report, then the Safety Office as a courtesy will contact the Principal Investigator of the laboratory with a reminder. If the laboratory conducts research, additional department designees may also be notified.
2. If no response is received and/or corrective actions are not completed after 60 days from receipt of the initial inspection report, the laboratory will be deemed noncompliant and information will be forwarded to the Dean's Office.

Previous inspection reports are a good measure for addressing safety issues and eliminating laboratory risks. To help prepare for future inspections, please review the "Laboratory Inspection Checklist" report, and perform self-inspections on a regular basis. The self-inspection process is an excellent learning tool for students and other lab personnel and should be documented as part of a lab specific safety training requirement.

Section 4: Laboratory Close-Out Procedure

The Safety Office must be notified prior to a laboratory move, relocation, or vacancy for any reason to perform a lab check-out assessment. This procedure will ensure that all hazardous materials are properly accounted for or disposed of and will prevent the next occupant from inheriting "unknown" or potentially hazardous materials. Contact the Safety and Risk Management Office (828-227-7443) to begin the closeout procedure.

Lab equipment that is broken or unwanted, such as refrigerators, freezers, incubators, centrifuges, etc., may be discarded through WCU Surplus. Equipment that could possibly be contaminated with biological, chemical, or radioactive materials must be decontaminated prior to disposal. Contact SRM to request an "Equipment Clearance" before scheduling pickup with the Surplus Department.

Section 5: Chemical Management

The requirement for chemical safety is one of the most critical components of an effective laboratory safety program.

Chemical Hazard Information

The Globally Harmonized System of Classification and Labeling of Chemicals (GHS) is an international system for standardizing and harmonizing the classification and labeling of chemicals. It is a logical and comprehensive approach to:

- Defining health, physical and environmental hazards of chemicals.
- Creating classification processes that use available data on chemicals for comparison with the defined hazard criteria; and
- Communicating hazard information, as well as protective measures, on labels and Safety Data Sheets (SDS).

Hazard Symbols and Labeling

Following GHS new labeling on chemical containers now must include:

- **The Product Identifier**: The name or number used to identify the chemical on the label and the SDS.
- **Hazard Pictograms**: Convey health, physical and environmental hazard information, assigned to a GHS hazard class and category.
- **Signal words**: The signal words "Danger" or "Warning" are used to emphasize hazards and indicate the relative level of severity of the hazard, assigned to a GHS hazard class and category. "Danger" indicates that the hazard associated with a chemical is *more severe,* while "Warning" signifies that the chemical is *less severe.*
- **Hazard Statements**: Statements assigned to a hazard class and category that describe the nature of the hazard(s) of a chemical, including, where appropriate, the degree of the hazard.
- **Precautionary Statement**: A phrase that describes recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to a hazardous chemical or improper storage or handling.
- **Supplier Identification**: The name, address, and telephone number of the manufacturer, importer, distributor, or other responsible party.

Table 1: New GHS Labeling Pictograms

 Acute Toxicity (severe)	 Corrosives	 Environmental Toxicity
 Explosives Self Reactives Organic Peroxides	 Flammables Self-Reactive Pyrophoric Self-Heating Emits Flammable Gas Organic Peroxides	 Gases Under Pressure

 Carcinogen Reproductive Toxicity Target Organ Toxicity Mutagenicity Respiratory Sensitizer Aspiration Toxicity	 Irritant Dermal Sensitizer Acute Toxicity (harmful) Narcotic Effects Respiratory Tract Irritation	 Oxidizers

All chemicals arriving from the manufacturer or distributor will come with GHS compliant labels. Employees are expected to know how to read and understand these labels.

Secondary Container Labeling

If chemicals are transferred to any secondary container (spray bottles, buckets, bottles, vials, etc.) they will need to be labeled with a secondary label that adequately depicts the chemical identification and associated hazards. An example of a compliant secondary label is depicted to the right. Include the following information on the secondary container label:

- Full chemical name (no abbreviations, formulas)
- Date of transfer or solution preparation
- Hazards, if applicable (flammable, corrosive, toxic, etc.)

If using small secondary containers (vials, tubes, etc.) where labeling requirements do not fit, it is acceptable to use a numbering system or abbreviations if there is a key detailing the contents clearly posted with the sample containers. Label ALL containers, including water.

Safety Data Sheets (SDS)

Safety Data Sheets (formerly MSDS) are prepared in accordance with the OSHA Hazard Communication Standard (29 CFR 1910.1200). They must be obtained or created by all chemical manufacturers and importers for every hazardous chemical they produce. The new SDS is now standardized in 16 sections and all manufacturers are required to use the same standardized 16-section format.

SDSs are available electronically from most major manufacturers. Smaller companies may distribute paper copies with the product. Laboratories must retain copies of any SDS that they receive and ensure that employees are granted access to them. Electronic accessibility of these documents is an acceptable substitute to paper copies only if the PI has ensured all laboratory personnel have demonstrated the ability to locate the necessary information and there is a backup means for obtaining an SDS in the case that the electronic system fails.

Exposure Limits

Occupational Exposure Limits (OELs) are airborne concentrations that have been set as safety limits for employees for a set period (8-hour working day). OSHA has published Permissible Exposure Limits (PELs) for many chemicals. The American Conference of Governmental Industrial Hygienists (ACGIH), a professional organization, has published Threshold Limit Values (TLVs). PELs and TLVs, as well as exposure limits published by other countries, may be specified in the SDS. Employees must be familiar with these terms and limits for the chemicals in use in the lab. If an employee suspects that their exposure may exceed the OEL they should contact the Safety and Risk Management Office immediately for exposure monitoring.

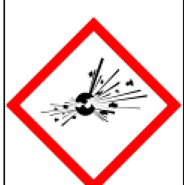
Chemical Storage

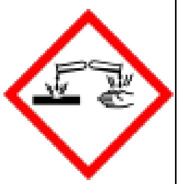
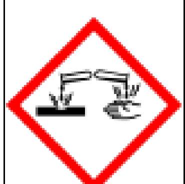
A major concern in many laboratories is the proper storage of chemicals. The best approach to this issue will vary depending on the chemical inventory of the lab and storage space available. To lessen the risk of exposure to hazardous chemicals, trained personnel should separate and store all chemicals according to hazard category and compatibility. In the event of an accident involving a broken container or spill, incompatible chemicals that are stored in proximity can mix to produce fires, hazardous fumes, and explosions. Prudent chemical management involves the following processes:

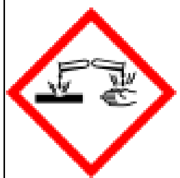
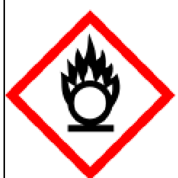
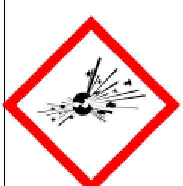
- Store chemicals in the smallest quantities possible. Excessive purchases of hazardous chemicals invariably result in increased safety risks, compliance tasks, and costs for disposal.
- Ensure all chemical containers are properly labeled. Laboratories may not remove or deface manufacturer labels.
- Secondary containers must be labeled with the required information on the original container **OR** the product identifier (full chemical name, no abbreviations) AND words, pictures, symbols, or combination thereof, which provide at least general information regarding the hazards of the chemical and will provide employees with specific information regarding the hazards of the chemical. The date of transfer or solution preparation should also be included on the secondary container label.
- When storing chemicals on open shelves, always use sturdy shelves that are secured to the wall and contain ¾ inch lips.
- Do not store liquid chemicals higher than 5 feet, on the floor, in the aisles or areas of egress, or on the benchtop. Designate a storage location away from heat and light and return containers to that location after each use.
- Store chemicals in compatible cabinets. Acids will corrode metal cabinets, so use an approved acid cabinet. Store flammable materials in an approved flammable cabinet. Only lab grade explosion proof refrigerators should be used to store chemicals that require cool storage. Domestic units should not be used to store chemicals as they possess ignition sources that can result in fires and explosions.

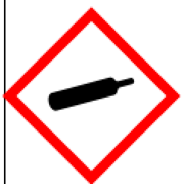
- Do not store chemicals in the fume hood. Excess storage interferes with the air flow and can become a source of hazardous materials discharge as well as a fire hazard.
- Use unbreakable secondary containers such as bins or bottle jackets for corrosive/hazardous liquids and other high hazard materials.
- Flammable materials in a quantity greater than 10 gallons must be stored in an approved flammable cabinet.
- Periodically inspect stored chemical containers for damage and label legibility. Damaged containers should be disposed of. Illegible labels should be replaced.
- Label the storage cabinets so areas of higher risk are easily identified (flammable, corrosive, toxic, oxidizer, water reactive, etc.)
- Store chemicals in compatible storage groups to prevent incompatible materials from reacting. Do not store chemicals in alphabetical order, except within the same storage group. Review the SDS to determine compatibility and storage requirements of chemicals in the lab.

Table 2: Chemical Compatibility Chart

Chemical Group	**Properties**	**Common Examples**	**Incompatible groups to store away from**	**Storage Considerations**
Flammable Liquids 	Flashpoint (FP) below 100°F Combustible liquids FP >100°F, <140°F FP is the lowest temperature at which a liquid gives off adequate vapor to ignite	Most Organic Liquids (alcohols, ethers, esters, aldehydes, ketones, etc.)	Oxidizers Acids Bases Volatile poisons	Approved flammable cabinet or explosion proof refrigerator. Avoid sources of ignition including outlet sparks, static electricity.
Peroxide Formers 	Highly flammable, low-power explosives, very sensitive to shock, sparks, light, strong oxidizers/reducers, friction, and high temperatures. High risk of explosion from distillation, evaporation, or on concentration	Diethyl ether, isopropyl ether, tetrahydrofuran (THF), acetal, potassium metal, sodium amide, dioxane, glyme, diglyme, furan, dicyclopentadiene, cyclohexene, acrylic acid, vinyl acetate, vinyl ethers	Oxidizers Acids Bases Volatile poisons	Approved flammable cabinet with other flammables. Date the containers when received and opened. Dispose of according to storage guidelines.

Chemical Group	Properties	Common Examples	Incompatible groups to store away from	Storage Considerations
Volatile Poisons 	Poisons, toxics, select/suspected carcinogens, mutagens, and teratogens. Chronic exposure is a health hazard.	Carbon tetrachloride, Dimethylformamide, mercaptoethanol, methylene chloride, phenol, chloroform, formaldehyde	Can be stored with other flammables but do not store volatile poisons, flammables, and bases together	Approved flammable cabinet or explosion proof refrigerator. Store in a sealed & labeled secondary container, not out on an open shelf.
Non-Volatile Liquid Poisons 	Highly toxic (LD_{50} less than 50mg/kg oral), carcinogens, mutagens	Acrylamide, ethidium bromide, triethanolamine	Oxidizing agents Acids	Store in a sealed & labeled secondary container, not out on an open shelf.
Oxidizing Acids 	Highly corrosive and reactive with each other and other substances	Sulfuric, Nitric, Perchloric, Phosphoric, Chromic acids	Flammables Organic/Mineral acids Bases Perchloric acid (>70%) reacts with wood/paper and may ignite. Do not store on wooden shelf.	Approved acid cabinet to prevent metal corrosion. Separate from other oxidizing acids using secondary containment.
Organic and Mineral Acids 	Highly corrosive	Inorganic/Mineral: Hydrochloric, phosphoric, hydrofluoric Organic: glacial acetic, acetic, butyric, formic, propionic, trifluoracetic acids	Oxidizing acids Bases Flammables Store separately from anhydrides as some can be very reactive with other acids. Store hydrofluoric acid separately.	Approved acid cabinet to prevent metal corrosion. Use secondary containment to prevent spills. Acid mists escape and build up inside unvented cabinets. Store in vented cabinet under fume hood if possible.

Chemical Group	Properties	Common Examples	Incompatible groups to store away from	Storage Considerations
Liquid Bases 	Highly corrosive	Hydroxides (sodium, ammonium, calcium, etc.), glutaraldehyde, aqueous ammonia	Acids Flammables Volatile Poisons	Corrosion proof cabinet using secondary containment. Store prepared solutions in polyethylene containers.
Oxidizers 	Provide oxygen that feeds fire and makes fires difficult to extinguish	Persulfates, peroxides, nitrates, nitrites, perchlorates, superoxides	Flammables Combustibles Reducing Agents.	Store in secondary containment and store larger quantities (>3L) in separate compartment.
Dry solids	All powders, hazardous and non-hazardous. Have different properties and various hazards, review the SDS.	Benzidine, cyanogens, bromide, oxalic acid, potassium hydroxide	Separate flammable solids from oxidizers, flammable liquids and corrosives.	Store above liquids and separate hazardous from non-hazardous.
Pyrophoric and Water Reactive 	Pyrophoric chemicals ignite spontaneously in air at temperatures below 130°F. Water reactive chemicals can react with moisture in the air to produce flammable gas. Metal hydrides react violently with water, and some with air.	Pyrophoric: alkyl/aryl metal/non-metals, metal carbonyls, diborane gas, organo-magnesium halides, metal/non-metal hydrides, metal powders, white phosphorous Water Reactive: aluminum chloride anhydrous, calcium carbide, acetyl chloride, alkali metals, calcium oxide, acid anhydrides.	Separate from other liquid chemicals and oxidizers. Store in air-tight, waterproof containers.	Store separately from flammable and combustible materials in a dry inert environment. These reactive chemicals require SOPs that cover storage practices and safe usage.

Chemical Group	Properties	Common Examples	Incompatible groups to store away from	Storage Considerations
Compressed Gas Cylinders 	Flammable Gases	Methane, hydrogen, acetylene, propane	Separate from oxidizing gases	Secure cylinders upright with proper securing device. Store with cylinder caps in place. Separate flammable and oxidizing gases.
	Oxidizing Gases	Oxygen, chlorine, bromine	Separate from flammable gases	
	Poisonous Gases	Hydrogen sulfide, carbon monoxide, nitrogen dioxide	Separate from oxidizing and flammable gases	

Chemical Inventory Control

A system for maintaining an accurate chemical inventory on campus is essential for compliance with local and state regulations and any applicable building codes. Every lab should maintain an up-to-date chemical inventory and a physical chemical inventory must be performed at least annually and submitted to the Safety and Risk Management Office. The benefits of performing an annual inventory include:

- Ensures chemicals are stored according to compatibility
- Eliminates unneeded or outdated chemicals
- Updates the hazard warning signage on the laboratory door
- Promotes more efficient use of lab space
- Checks expiration dates of peroxide formers
- Ensures integrity of shelving and storage cabinets
- Replaces illegible or missing labels

The chemical inventory should include the following information:

- Chemical name
- Chemical Abstract Number (CAS)
- Manufacturer & product number (reorder #, catalog #, etc.)
- Quantity & storage location

Section 6: Time Sensitive Chemicals

Some chemicals require special consideration and careful monitoring for storage, handling, and use. This section details the hazards and necessary precautions for some chemicals that develop additional risk upon prolonged storage and are commonly found in laboratories on campus. These chemicals must be monitored and disposed of at regular intervals to avoid costly and dangerous situations if extended storage has formed hazardous by-products.

Peroxide Forming Chemicals

Certain organic chemicals react with air at ordinary temperatures to form peroxide compounds which can react violently or explosively! Organic peroxides are substances that contain the peroxo group (R-O-O-R) and are classified as low-power explosives. These compounds are hazardous due to their sensitivity to shock, sparks, or other source of ignition such as heat, friction, sunlight, impact, or reaction with strong oxidizing/reducing agents. Due to this unusual instability and the fact that peroxide formation increases with age, it is important to label all peroxide forming chemicals with the date received and the date opened and follow the storage and disposal guidelines indicated below. Some common peroxide forming chemicals are listed, but always check the SDS for confirmation of storage/disposal guidelines for the chemicals in your lab.

Label Peroxide Forming Chemicals

CAUTION! PEROXIDE FORMING CHEMICAL
Date Received: ___________________________
Date Opened: ____________________________
Date Expires: _____________________________
Test Date/Result: __________________________

Table 3: List of Common Peroxide Formers

Common Compounds That Form Peroxides During Storage		
Risk Category	**Examples**	**Disposal Guidelines**
MOST DANGEROUS Peroxide formation occurs during storage. Form explosive levels of peroxides without concentration	diisopropyl ether (isopropyl ether) potassium metal potassium amide divinyl acetylene sodium amide (sodamide) vinylidene chloride	Test for peroxide formation before use and discard within **3 months**
DANGEROUS Peroxide formation occurs during storage and becomes more hazardous when the peroxides are concentrated upon evaporation or distillation	Diethyl ether Tetrahydrofuran Dioxane Acetal Ethylene glycol dimethyl ether Furan Vinyl ethers Dicyclopentadiene Cyclohexene Diethylene glycol dimethyl ether	Test for peroxide formation before distillation or evaporation and discard within **12 months**

Common Compounds That Form Peroxides During Storage		
Risk Category	**Examples**	**Disposal Guidelines**
DANGEROUS May initiate exothermic polymerization which could rupture the container, release toxic gas, or initiate combustion	Methyl methacrylate Styrene Acrylic acid Acrylonitrile Butadiene Vinylidene chloride Chlorofluoroethylene Vinyl acetate	Test for peroxide formation before use and discard within **12 months**

Safe practices for storing and handling peroxide forming chemicals:

- If visible crystals are evident in a peroxidizable liquid or discoloration is observed in a peroxidizable solid, **DO NOT HANDLE** the chemical and contact the Safety Office immediately (828-227-7443). These conditions indicate a higher concentration of peroxide formation and require special handling and disposal procedures.
- Purchase quantities of peroxidizable compounds according to short-term needs. Avoid bulk-purchasing to save money as this often results in excess materials with peroxidation potential and subsequent disposal costs.
- Label the container with date received, opened, and expiration.
- Follow the recommended storage and disposal guidelines in the table above or as listed on the SDS.
- Test for peroxide formation per the recommended guidelines and record the date and test results. Peroxide test strips are available from commercial vendors and are convenient to use. For results less than 30 ppm, the chemical may be stabilized by adding an inhibitor or removing the peroxides.
- DO NOT USE if the peroxide test result is greater than 30 ppm and contact the Safety Office for disposal.
- When transferring peroxide forming chemicals from a stock bottle into a new container, label the new bottle with the received, opened, & expiration dates listed on the original stock bottle.
- Store peroxide forming chemicals in a flammable cabinet or explosion proof refrigerator if cooler temperatures are indicated on the SDS.
- Keep away from sources of heat and sunlight.
- Routinely test peroxide forming solvents before distillation or evaporation and don’t distill to dryness. Leave at least 10% volume of liquid in the container to ensure safety.
- Properly reseal the containers to limit atmospheric contaminants (particularly oxygen).
- Empty containers of ethers and other peroxide-formers must be triple rinsed with water before discarding.
- Always wear proper personal protective equipment (PPE) in the lab. Wearing a lab coat and clothing that minimizes exposed skin provides better protection when working with chemicals.

- Work behind a safety sash such as a fume hood, plexiglass shield, or face shield, when working with potentially explosive chemicals. Rotovap explosions have occurred in the lab, so always be careful when using peroxidizable solvents in the rotovap – test the solvent for peroxides before using and shield the rotovap flasks to prevent injury from flying glass fragments in the event of an explosion!
- Always know where the emergency eyewash and safety shower are located before beginning work in the lab.
- Avoid working alone in the lab during business hours and if necessary, use a buddy system to periodically check in. Never work alone during off-hours (evenings, weekends, or holidays).

Chloroform

Chloroform reacts with air to form highly toxic phosgene gas and hydrochloric acid upon prolonged storage and exposure to light. Signs of deterioration may not be visibly evident so confirm the bottle dates before use. A low pH can be used as an indicator for hydrochloric acid formation and the presence of phosgene can be detected with the following indicator strip method:

- Strips of filter paper dipped in 5% w/v Diphenylamine and 5% w/v Dimethylaminobenzaldehyde ethanol solution and then allowed to dry. Strips should be a very light yellow when dry and activate to a dark yellow/orange color upon presence of phosgene.
- Wear appropriate PPE and handle chloroform in a fume hood.

Unstabilized chloroform should be disposed of within 12 months even if unopened. Opened containers of chloroform with a stabilizer other than ethanol should be disposed of within 12 months of opening. Chloroform stabilized with ethanol should be disposed of within 5 years.

Shock Sensitive Chemicals

Shock sensitive chemicals can detonate due to heat, friction, or shock. Identify these chemicals and take precautions for storage and handling as detailed on the SDS. Examples include, but are not limited to the following:

Acetylene	Ethylene oxides	Metal Fulminate
Acetylides of heavy metals	Fulminating Gold	Nitrogen triiodide
Ammonium nitrate	Fulminating Silver	Nitrogen trichloride
Ammonium percholate	Fulminate of Mercury	Nitroglycerin
Ammonium picrate	Germanium	Nitroglycol
Azides of heavy metals	Hexanitrodiphenylamine	Nitroguanidine
Calcium nitrate	Hexanitrostilbene	Nitrourea
Chlorates	Hydrazine	Ozonides
Dinitrotoluene	Hydrazoic acid	Perchlorate of heavy metals
Dinitrophenol	Lead styphnate	Perchloric Acid
		Picric acid

Polynitrated Aromatics are a class of chemical containing highly reactive nitrate (NO_3) functional groups that can form explosive salts when exposed to certain metals. Examples include picric acid, dinitrotoluene, dinitrophenol, hexanitrostilbene, and nitroglycerin.

Picric acid must be kept wet and can become explosive if the water content falls below 10% by volume. Signs of deterioration may include a pale color, visible crystals, or a white film around the neck of the container. Do NOT touch the container if deterioration is suspected! Picric acid should be disposed of within 2 years of receipt.

Hazard Controls for Time Sensitive Materials

- Substitute with a less hazardous chemical whenever possible.
- Purchase the smallest amount feasible to complete the work. Avoid stockpiling to save money, as increased risk for a dangerous situation and disposal of expired product in the future far outweighs the initial cost savings! Purchase the stabilized chemical whenever possible.
- Clearly label the container with date received, date opened, and expiration date.
- Review the chemical Safety Data Sheet (SDS) before using the material.
- Store in a cool, dry, well-ventilated area away from heat sources. Always store separately from incompatible materials and follow manufacturer instructions.
- Always wear appropriate PPE as indicated on the SDS and at a minimum safety goggles, gloves, and proper laboratory attire.
- Always handle in a chemical fume hood.
- Do not store in ground glass stoppered bottles or bottles with metal-lined foil caps.
- Store in dark colored glass to avoid reactions with light.
- Look for signs of deterioration before opening the container. If signs of deterioration are evident (crystals, bulging container, color) do NOT open and contact Safety and Risk Management immediately (828-227-7443).
- Contact Safety and Risk Management for disposal of chemicals that are at or beyond the expiration date.

Section 7: Dispensing Flammable Liquids

The flow of flammable and combustible liquids can cause a buildup of static electricity, and when enough of a charge builds up a spark can occur with the potential to cause a fire or explosion. The likelihood of this happening is dependent upon how well the liquid conducts electricity, its flash point, and the capacity to generate static electricity.

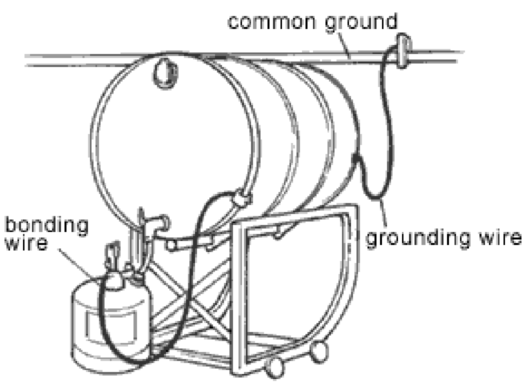
When dispensing flammable or combustible liquids from one container to another, it is important that proper grounding and bonding practices be followed to control for static electricity. All containers of Category 1, 2, or 3 liquids with a flashpoint less than 100^{o}F are required to be bonded and grounded during dispensing.

Bonding eliminates the electrical potential between two containers therefore eliminating the likelihood of sparks. A bonding wire is connected between the dispensing container and the receiving container.

Grounding eliminates the difference in static potential charge between the conductive object and the ground. Grounding is accomplished by connecting the conductive object directly to the earth, usually using cold water copper pipes, building steel, or a grounding bar.

It is critical that a metal-to-metal connection be made between the containers, so the area of the connection is clean from dirt, rust, and paint for proper bare metal contact. When transferring liquids, the potential for spills exists so a spill tray should be positioned below the faucet to catch leaks.

The diagram below is an example of a bonding and grounding system that provides an electrically conductive pathway for static electricity to dissipate into the ground.



Assessment of Bonding and Grounding: Test the resistance of the bonding-grounding connections with an ohmmeter. To prevent the accumulation of static electricity, the total resistance of the grounding circuit should be less than 10 ohms (Ω).

Plastic and Glass Containers: Static hazards may also exist in non-metallic plastic or glass containers that cannot be grounded, and static electricity may be generated by the free fall and turbulence of the liquid being poured. To minimize this hazard, pour as slowly as possible and use a grounded nozzle extension that allows filling the container from the bottom.

Safety Cans: Safety cans have self-closing air-tight lids and a flame arrester that protects the contents from an external ignition source. Bonding and grounding is still required when filling or dispensing from safety cans since static electricity generation is possible.

Section 8: Compressed Gas

Compressed gas cylinders present a variety of hazards due to the pressure and contents in the container. This section covers the requirements which must be followed for the use of all compressed gases on campus. In addition to the standard required work practices for inert gases, hazardous gases may require additional controls and work practices including, but not limited to, the use of gas cabinets, gas monitors, emergency shutoffs, proper equipment design, leak testing procedures, and the use of air supplying respirators for certain highly toxic gases. Contact the Safety and Risk Management Office for further assistance with the safe design of equipment involving the use of hazardous gases.

Laboratory principal investigators and work supervisors are responsible for assuring that the requirements are followed by all personnel under their supervision who use or handle compressed gas cylinders during the course of their work.

Compressed Gas Use Applications

Use of Inert Gas: Inert gases are non-flammable and non-toxic but may cause asphyxiation due to displacement of oxygen in poorly ventilated spaces. Inert gases commonly found on campus include Carbon dioxide, Argon, and Nitrogen gas.

Use of Flammable, Low Toxicity Gases: These gases are flammable but act as non-toxic simple asphyxiates. Examples include hydrogen, acetylene, and methane. Flammable gases can be ignited by static electricity or by a heat source such as a flame or hot object. Oxygen and other oxidizing gases will support combustion of flammable materials and must be kept separate from flammable gases.

Use of Pyrophoric and Highly Reactive Gases and Liquids: These gases spontaneously ignite on contact with air at a temperature of 130^{o}F or below. Examples include phosphine, arsine, silane, diborane, and anhydrous ammonia. Silane has caused major losses due to fires in ducts, gas cabinets, and supply systems and most incidents have occurred in research facilities. Pyrophoric fires are difficult to extinguish.

Use of Corrosive, Toxic, and Highly Toxic Gases: These gases may cause acute or chronic health effects at relatively low concentrations in air. Corrosive gases can cause rapid destruction of skin tissue and can chemically attack various materials, including fire-resistant clothing. Some gases are not corrosive in their pure form but can become extremely destructive if a small amount of moisture is added. Chemical poisoning is the primary hazard of toxic gases, and even in very small concentrations, brief exposure can result in serious poisoning injuries. Examples of these gases include hydrogen chloride, ethylene oxide, nitrous oxide, carbon monoxide, and hydrogen sulfide.

Use of Fuel Gases for Welding, Cutting, Brazing: These gases are used for welding and cutting applications. Common examples include oxygen, propane, and acetylene.

Compressed Gas Use in Fume Hoods

Toxic gases, such as carbon monoxide and hydrogen sulfide should be stored and used in a chemical fume hood. Since fume hood face velocities provide insufficient protection against pressurized gas leaks, special care must be taken when hazardous gases are used in fume hoods. The following is required for fume hood applications:

- Use the smallest possible cylinder size and when possible order returnable bottles with the lowest cylinder pressures.
- Use a flow restricting orifice or needle valve to restrict flow to only that needed for the experiment.
- Toxic and corrosive gases must be used with a normally closed, pneumatic shutoff valve located immediately downstream of the cylinder regulator and which closes with exhaust loss or power failure.

- Place the cylinder in the rear of the hood to prevent high pressure leaks from escaping out of the hood.
- Ensure all components in the experiment can withstand full bottle pressure.
- Keep all purge lines and gas supply lines within the hood.

General Compressed Gas Safety Practices

Wear appropriate Personal Protective Equipment (PPE) when transporting, connecting, and disconnecting gas regulators and transfer lines. Minimum PPE should include approved safety glasses, closed-toed shoes, and gloves and clothing to protect skin from frostbite (cryogens), corrosives, or pinch points. A face shield should be used if face protection is necessary.

Always check the label on the cylinder. It should be legible and clearly indicate the contents with either the chemical or trade name of the gas. Never accept a cylinder that is not labeled correctly and do not rely on the color coding of the tanks/caps, this is not a reliable indicator of what is inside the tank.

If the labeling on the gas cylinder becomes unclear or defaced so that the contents cannot be identified, the cylinder should be marked “contents unknown” and the manufacturer must be contacted regarding appropriate procedures for removal.

Storing Compressed Gas Cylinders

All gas cylinders must always be secured with proper securing devices such as straps and clamps. Cylinders must be secured when full and when empty. The screw on cylinder caps must always be in place when the regulator is not connected to provide mechanical protection. Regulators must be removed, and cylinder caps replaced prior to movement of compressed gas cylinders.

- Strap/chain the gas cylinder to a secure fixture at a height of 1/2 to 2/3 of the cylinder height.
- Secure fixtures include a properly secured wall mount, properly maintained and securely tightened bench mount, or secure floor support that doesn’t present a tripping hazard.
- Strap each individual cylinder rather than strapping a group of cylinders together.
- Always store the cylinders upright with valve caps in place when not in use.
- Segregate full and empty cylinders.
- Separate flammable gases from oxidizing gases and other combustible materials (separation distance of 20 feet or a 5-foot-high fire-rated wall).
- Store cylinders in a cool, dry, well-ventilated, and secure area.
- Cylinder storage areas should be protected from extreme heat or cold, prevent temperatures from exceeding 125°F, and should have limited access to only authorized personnel.
- Store away from heavily traveled areas and emergency exits.
- Visually inspect storage areas on a routine basis for any indication of leakage or problems.
- Post signage in the storage area to indicate potential hazards (flammable gas, oxygen, etc.).

Handling Compressed Gas Cylinders

Compressed gas cylinders should be handled only by personnel who have been properly trained. Cylinders are heavy and awkward to move and improper handling can result in serious injury. Use the following precautions when handling compressed gas cylinders:

- Never drag, roll, or slide containers.
- Always leave the valve protection cap in place when transporting the cylinder and when securely stored until ready to be used.
- Always use a suitable cart to transport cylinders.
- Don't try to catch a falling cylinder.
- Don't allow grease or oil to come in contact with oxygen cylinder valves, regulators, gauges, or fittings; an explosion or fire can result. Oxygen cylinders and apparatus must be handled with clean hands and tools.
- Refer to the SDS for the gas and use the proper precautions and PPE.
- Always use the regulator approved for the specific gas. Do not force cylinder valve connections that do not fit.
- Open the cylinder valve slowly, directed away from your face.
- Do not attempt to refill compressed gas cylinders; this can only be done by a qualified manufacturer of compressed gases.
- Only use non-sparking tools when working with flammable gases.
- When finished using the gas close the cylinder valve and release all pressure from the downstream equipment.
- Disconnect the cylinder anytime there is an extended non-use period and cap the cylinder.

Regulators, Tubing, and Piping Connections

Gases must be dispensed using systems that are cleaned and compatible with the gas in use. Use hard piping (copper, stainless steel) when possible, as opposed to flexible or plastic tubing. When flexible tubing is used, select compatible tubing, and use it within line of sight (not under doors, through walls, ceilings). Replace old flexible tubing before it deteriorates. Secure tubing to keep it in place.

Don't use Teflon tape on cylinder connections. Use Teflon only on pipe threads where the seal is made at the threads. Always leak-check tubing or piping connections.

Regulators reduce the high-pressure gas to a lower usable level and provide additional safety measures. Only use a regulator for the gas for which it is intended and never force a connection.

Lecture Gas Bottles

Lecture bottles are small compressed gas cylinders, typically 12-18 inches long and 2-3 inches in diameter. They are typically used for holding calibration gases or in applications that require smaller quantities of gas. The following precautions should be followed for storing and using lecture gas bottles:

Lecture Bottle Use: Inspect the bottle and regulator before use and never use if corroded or damaged.

- Only use regulators and tubing appropriate for the gas (i.e. Use stainless steel for corrosive gases). Using the wrong regulator can compromise gas purity, cause equipment failure, and result in injury to personnel.
- Label the regulator with the gas it is to be used for to prevent improper use.
- Properly secure the cylinders in an upright position using an approved lecture bottle stand during use.
- Lecture bottles containing toxic gases (i.e. Hydrogen sulfide, carbon monoxide, nitrous oxide) must be used in a fume hood or gas cabinet.

Lecture Bottle Storage: Ensure that lecture bottles are stored upright and secured in a way to prevent them from falling. Lecture bottle holders can be purchased for this purpose.

- Non-corrosive gas cylinders may be stored horizontally in specifically designed racks to prevent movement. Do not stack cylinders.
- Remove the regulator when storing cylinders.
- Separate incompatible gases such as flammable and oxidizing gases.
- Store poisonous gases in a fume hood or ventilated gas cabinet.
- Lecture bottles must be properly labeled with contents, date received, and hazards.
- If the bottle is completely empty (no material will escape if the valve is opened), clearly label as "empty" and store separately.
- Anhydrous hydrogen fluoride lecture bottles must be disposed of within 2 years of purchase. Over time the HF reacts with iron in the steel container to form iron fluoride and hydrogen gas. The hydrogen pressure can build up and cause the cylinder to rupture!

Lecture Bottle Purchase and Disposal: Lecture bottles may not be refillable or returnable to the gas manufacturer and the disposal cost can be significant. This is something to keep in mind when purchasing lecture bottles, and it is recommended that laboratories purchase from vendors who do take back lecture bottles, whenever possible. Sigma Aldrich and Matheson Tri-Gas are two such vendors that may take back bottles for a small fee if they have been purchased from them and are in good condition.

Contact the Safety and Risk Management Office if you have gas lecture bottles to dispose of (828-227-7443).

Cryogenic Liquids

A cryogenic liquid is defined as a liquid with a normal boiling point below 240°F (-150°C). Only inert gases are permitted in portable cryogenic containers. Liquid oxygen, liquid hydrogen or other flammable or toxic cryogenic liquids are not permitted.

All cryogenic liquids should be used with caution due to the low temperature and hazards associated with pressure buildup in enclosed piping or containers. Portable containers should only be used where there is sufficient ventilation. Do not place containers in an enclosed space where there is no ventilation supply to the area as the buildup of inert gas in such an area could generate an oxygen deficient atmosphere and result in asphyxiation.

Cryogen Use Precautions

Cryogenic liquids are extremely cold and can rapidly freeze human tissue on contact. Prolonged exposure can cause frostbite. There is no initial pain but there will be intense pain when frozen tissue thaws. Unprotected skin can stick to surfaces (particularly metallic surfaces) cooled by cryogenic liquids and then tear when pulled away. Prolonged breathing of extremely cold air may damage the lungs. When transferring cryogens, loose fitting cryogenic handling gloves must be used and precautions taken to eliminate exposed skin and protect the eyes. Containers to be filled with cryogenic liquids should be filled slowly to avoid splashing.

Use and store cryogenic fluids in well ventilated areas only. Tremendous pressures can develop in enclosed spaces as the liquid converts to gas. For example, one cm^3 of liquid nitrogen will expand to 700 times this volume as it converts to its gaseous state. Vacuum jacketed containers, designed to minimize heat loss, will have overpressure relief valves in place and cryogenic liquids will vent as part of normal operation. As an example, a 160-liter tank will vent the gas equivalent to 2 liters of liquid a day. Excessive venting or an isolated ice build-up on the vessel walls may indicate a fault or problem and if this occurs the vessel should be removed from service and taken to a safe well-ventilated area immediately.

All cryogenic liquids produce large volumes of gas when they vaporize and can displace the normal oxygen volume in enclosed spaces. When the oxygen content (normally 21%) is reduced to 15-16%, an individual will lose consciousness without warning. When there is not enough oxygen, asphyxiation and death can occur very quickly! Even a few breaths of oxygen-depleted air can cause a rapid drop in dissolved oxygen in the blood resulting in mental failure and coma within seconds.

General Cryogen Safety Practices

- All cryogenic liquids must be stored in a well-ventilated area.
- Dewars are non-pressurized, vacuum-walled containers that are equipped with a loose-fitting cap or open top and should be used for small amounts of cryogenic liquid.
- Cryogenic liquid containers that are sealed, vacuum-walled, and fitted with pressure release valves should be used to store cryogens. Dewars can be filled from these containers.
- Use the recommended PPE for handling cryogens: loose fitting thermal insulated or leather gloves, long sleeved shirts and trousers, and safety glasses.
- Do not wear metal jewelry, rings, watches, etc., while transferring cryogenic liquids.
- Transfer cryogens slowly to avoid splashes. Open transfers are allowed only in well-ventilated areas.
- Use tongs or other devices to immerse and remove objects from cryogenic liquids.

Dewar Safety

Dewars are usually used for liquid nitrogen. Contact of liquid nitrogen or any very cold gas with the skin or eyes may cause frostbite injury. The gas issuing from the liquid is extremely cold. Delicate tissue, such as that of the eyes can be damaged by an exposure to the cold gas which would be too brief to affect the skin of the hands or face. Always protect hands and eyes when working with liquid nitrogen. Always wear cryogenic gloves that are loose fitting and can be thrown off quickly if liquid should splash into them. Any kind of canvas shoes should be avoided because a liquid nitrogen spill can be taken up by the canvas resulting in a far more severe burn.

Do not use any stopper or other device in the opening of the liquid nitrogen dewar that would interfere with venting of the gas. Inadequate venting can result in excessive gas pressure which could damage or burst the container.

Use a phase separator or special filling funnel to prevent splashing and spilling when transferring liquid nitrogen into or from a dewar. Use only small, easily handled dewars for pouring liquid. For larger containers, use a cryogenic liquid withdrawal device to transfer liquid from one container to another. Be sure to follow instructions supplied with the withdrawal device. Avoid overfilling the containers to prevent spillage of liquid.

Transporting Cryogen Containers

Move cryogenic liquid containers carefully. Do not move a container by rolling it on its lower rim. Always use a hand truck, cart, or other proper handling device. Use a strap to secure the container to the handcart. Always keep the containers upright except for minor tilting on the cart during transport. Always push rather than pull the container as pushing reduces the chance of the container falling on you or a co-worker.

If cryogens must be transported by elevator, take adequate precautions to prevent possible injury. Send the cryogenic liquid container in the elevator without any passengers and have people stationed at each floor to ensure that no passengers get on the elevator while the cryogen is being transported. Place someone at the destination floor to retrieve the cylinder. This process will ensure that if a power failure occurred, or if the tank malfunctioned, a passenger would not be trapped in the confined space of an elevator with the cryogen. Excessive amounts of the cryogen could vaporize and displace the oxygen in the elevator, quickly creating an asphyxiation hazard.

Compressed Gas Emergency Procedures

Asphyxiation - Never enter an area suspected of being oxygen-deprived without a source of supplied air. Use monitoring devices to ensure oxygen levels are adequate.

Anyone suffering from lack of oxygen should be quickly moved to an area with normal atmosphere. If the victim is not breathing, artificial respiration should be administered immediately. Give supplemental oxygen with respiration if oxygen is available.

Frostbite - For skin contact remove any clothing that may restrict circulation to the frozen area. Do not rub frozen parts as tissue damage may result. Place the affected area in a warm water bath with a temperature that does not exceed 105°F (40°C). Do not apply dry heat. Seek medical treatment as soon as possible. Frozen tissue is usually pain-free and appears waxy with a possible yellow color. It will become swollen, painful, and prone to infection when thawed.

Faulty Equipment - If a Dewar or larger container of cryogenic liquid is venting continuously or forming ice on the surface, call the supply vendor immediately.

Compressed Gas Training Requirements

Any employee who physically transports and makes regulator connections to compressed gas systems is required to take the compressed gas safety training. Contact the Safety Office directly to be enrolled in this training if you have not previously indicated this as a job duty on the Hazard Assessment Training Determination Form. Lab specific training provided by the PI or Lab Supervisor is considered adequate for personnel who connect tubing and adjust flow valves for inert, flammable, and low toxicity gases used in the lab.

Dry Ice Handling and Disposal

Dry ice, or solid-state carbon dioxide (CO_2), is commonly used in research and for transporting perishable materials in shipment. Its physical properties allow for rapid cooling of materials and the ability to maintain cold temperatures much longer than regular ice. Dry ice is available in flakes, pellets or block form and poses some unique hazards. The following precautions and safety guidelines should be followed when storing, handling, and disposing of dry ice.

Contact Hazard: Contacting dry ice with bare skin can result in burns and severe frostbite within seconds. The temperature of dry ice (-109^{o}F, -79^{o}C) can also damage surface materials it contacts so care must be taken to use insulated materials for storage.

- Do not touch dry ice with bare skin. Always use loose-fitting insulated gloves, safety glasses and/or face shield, and proper lab attire such as long-sleeved clothing, closed-toed shoes, and long pants.
- Use tongs to handle dry ice whenever possible.
- Do not place dry ice on a solid surface as it could crack the surface or destroy surface adhesives.
- Do not store in the freezer compartment of a refrigerator as it could lower the programed temperature and cause the appliance to malfunction.
- Do not dispose of dry ice down the drain or toilet as it could cause pipes to freeze and burst.

Sublimation Hazard: Dry ice sublimes (changes from solid to gas phase) at temperatures above -109^{o}F (-78^{o}C). During sublimation carbon dioxide gas is released causing the potential for explosion if left in a sealed airtight container or simple asphyxiation if released into an enclosed area. Approximately 1 pound of solid dry ice will release 250 liters of gas.

- Store dry ice in a well-ventilated area. Do not store in confined areas such as cold rooms, walk-in refrigerators, or environmental chambers.
- Do not store in the fridge or inside an ultra-low freezer as it could result in excess carbon dioxide buildup inside the appliance.
- Do not store in an air-tight container or any container with a screw-cap lid that will not vent. Use containers specifically rated for use with dry ice. Styrofoam is acceptable as it is insulated and not airtight.

Disposal of Dry Ice

- Place the Styrofoam container of dry ice in a well-ventilated area at room temperature until the dry ice has completely sublimed. Ideally, the container should be placed inside an operating fume hood. It generally takes 24 hours for 5-10 pounds of dry ice to sublimate.
- Do not dispose of dry ice down the drain or in the trash.
- Do not leave unattended in open areas or public spaces. Leaving dry ice in a shared hallway puts others at risk of contact burns with the substance.

First Aid: If skin exposure occurs, remove any clothing and jewelry that is not frozen to the skin. Do NOT rub the frozen body part as tissue damage could result. Place the affected body part in luke-warm water (below 95°F or 35°C) for 10-15 minutes. Seek medical attention as soon as possible.

Section 9: Controlled Substances

A controlled substance includes any drug or chemical substance whose possession and use are regulated under the United States Controlled Substances Act (CSA), or the North Carolina Controlled Substances Act (NC CSA). These substances have stimulant, depressant, or hallucinogenic effects on the higher functions of the central nervous system and tend to promote abuse or physiological/psychological dependence. Registration is required for any substance listed in Schedules I-VI at the State level (NC-DCU) and at the Federal level (US-DEA). The Safety and Risk Management Office must be notified to determine licensing and regulatory requirements prior to initiating work with a controlled substance at WCU.

Section 10: Safety Rules and Best Lab Practices

The most important rule is that everyone involved in laboratory operations from the highest administrative level to the individual workers must be safety minded. Safety awareness can become part of everyone's habits only if safety is discussed repeatedly and only if senior and responsible staff demonstrate a sincere and continuing interest in safety. Over familiarity with an operation can result in overlooking or underrating its hazards and can provide a false sense of security which frequently results in carelessness and laboratory accidents. Be alert to unsafe conditions and call attention to them so that corrections can be made as soon as possible. Every laboratory worker has a basic responsibility to himself/herself and colleagues to plan and execute laboratory operations in a safe manner. The sections that follow are areas that should be observed and questioned regarding the safety in your laboratory.

Risk Reduction: Hierarchy of Controls

Use a hierarchy of controls that places emphasis on keeping hazards out of the workplace when possible. Below is the hierarchy, by order of effectiveness (with one being the most effective).

1. **Elimination**: Eliminate the need for the hazardous material. An example would be purchasing precast polyacrylamide gels to avoid potential exposure to acrylamide powder, a Particularly Hazardous Substance (PHS).

2. **Substitution**: Substitute the hazardous material for a less hazardous one. An example would be substituting xylene or toluene-based reagents with citric acid based reagents or changing the

temperature, pressure, or using an inert gas during an experiment to reduce the likelihood of exposure.

3. **Engineering Controls (Safeguarding Technology):** Engineering controls place a barrier between the worker and the hazard. An example would be chemical fume hoods or soundproof rooms for noisy equipment. Laboratory equipment should only be used for its designated purpose and used in accordance with manufacturer's guidelines. Inspect equipment for damage before use, and do not use damaged or malfunctioning equipment.

4. **Administrative Controls:** Training and procedures in place to help reduce your chance of being exposed to a hazard. The following are examples of administrative controls:

   - **Scheduling:** Used to reduce the intensity of exposure that any given employee has to a task in the laboratory. By scheduling a variety of tasks, supervisors can reduce ergonomic risk factors from static postures or repetitive motion. Engineering controls and work practices should be used to control chemical exposures wherever possible, but when those means have been exhausted, task schedules and employee rotation can reduce exposures.

   - **Limiting access to the laboratory:** Laboratory work areas with hazardous chemicals should be secured when unattended, and laboratory visitors must be accompanied by laboratory personnel.

   - **Work removal:** In some instances, it may be necessary to remove an employee from a work area or restrict employees from performing specific laboratory tasks that may adversely affect their health, particularly in the case of sensitivity, allergens, or pregnancy.

5. **Personal Protective Equipment (PPE):** PPE is the least effective control measure when evaluating risk because it is the last line of defense between the hazard and the employee. If a hazard assessment has indicated that PPE is necessary, ensure that you use the appropriate PPE to prevent contact with skin and mucous membranes.

Working Alone

Generally, it is prudent to avoid working in a laboratory building alone. Under normal working conditions arrangements should be made between individuals working in separate laboratories outside of working hours to crosscheck periodically. Alternatively, security officers may be asked to check on the laboratory worker. Experiments known to be hazardous should not be undertaken by a worker who is alone in a laboratory. The supervisor of the laboratory has the responsibility for determining whether the work requires special safety precautions, such as having two persons in the same room during an operation.

Laboratory personnel working autonomously or performing independent research also have the following responsibilities:

- Provide the PI/Laboratory Supervisor with a written scope of work for the proposed research.
- Notify and consult with the PI/Laboratory Supervisor, in advance, if they intend to deviate from the written scope or scale of work.

- Provide appropriate oversight, training and safety information to laboratory personnel they supervise or direct.

Unattended Operations

Frequently, laboratory operations are carried out continuously or overnight. It is essential to plan for interruptions in utility services such as electricity, water, and inert gas. Operations should be designed to be safe, and plans should be made to avoid hazards in case of failure. Wherever possible, arrangements for routine inspection of the operations should be made and, in all cases, the laboratory lights should be left on and an appropriate sign should be placed on the door. If circumstances dictate that an experiment must be run when the lab is not occupied, seek the approval of the PI in advance, and ensure that contact information for the person familiar with the experiment is on site so they may be contacted if the need arises.

Housekeeping

There is a definite relationship between safety performance and orderliness in the laboratory. When housekeeping standards decrease, safety performance inevitably deteriorates. General housekeeping is imperative for ensuring the safety of laboratory employees.

- Wipe down benchtop surfaces whenever there is visible contamination and before leaving the laboratory to avoid contaminating the work, yourself, or another employees' clothing.
- Keep items off the floor, especially chemical storage containers, so that housekeeping can clean effectively, and to reduce the risk of trips/falls and chemical spills.
- Never obstruct access to exits and emergency equipment (fire extinguishers, safety showers, eyewash stations, etc.). A 3-foot clearance should be maintained for access.
- Remove all unnecessary materials and equipment from the work area (broken/unused equipment, empty boxes, etc.).
- Chemicals that are no longer needed should not be permitted to accumulate in the laboratory.
- Chemicals and equipment must be properly labeled and stored.
- Wastes are to be deposited in appropriately labeled receptacles. Use secondary containment for waste containers to prevent spills.
- Trash bags should be emptied when full, either by lab personnel at the end of their working shift or by housekeeping if it is a lab designated for housekeeping services.
- Use cable management devices to eliminate trip hazards from cords and cables, and to bundle them together when excess is present, especially under desks and lab benches. Avoid over-hanging cables from the ceiling.
- Do not store items close to the ceiling or in any area that would prevent the normal flow of water from the sprinkler system in the event of a fire. Storage should be maintained 2 feet or more below the ceiling in non-sprinklered areas or a minimum of 18" below the ceiling in sprinklered areas of the building.

Food, Drink, Tobacco, and Cosmetic Application

Contamination of food, drink, tobacco materials, and cosmetics is a potential route for exposure to toxic substances. Coffee, soft drinks, snacks, and lunches are not to be brought into laboratory areas. Food should be stored, handled, and consumed in an area free of hazardous substances.

Non-laboratory areas, such as nearby break rooms, lounges, or conference rooms should be designated for storage and consumption of food and beverage for laboratory personnel. Areas where food is permitted should be prominently marked and warning signs (e.g., EATING AREA CHEMICALS NOT PERMITTED) posted. Separate equipment (fridge/microwave etc.) should be dedicated to that use and prominently labeled.

Glassware or utensils that have been used for laboratory operation are not to be used for food or beverages. Laboratory refrigerators, ice chests, cold rooms and such are not to be used for food storage. This is an effort to prevent accidental ingestion of a hazardous substance. If food, drugs, or household items are to be used in the laboratory, they must be labeled "FOR LAB USE ONLY." Any household appliance used in the laboratory (refrigerator, microwave, blender, etc.) must also be labeled "FOR LAB USE ONLY".

Warning Signs and Labels

Laboratory areas that have special or unusual hazards must be posted with warning signs. Standard signs and symbols have been established for special situations, such as radioactive materials, radiation hazards, biological hazards, fire hazards, and laser operations. Other signs should be posted to show the locations of safety showers, eyewash stations, exits, and fire extinguishers.

The safety and hazard sign systems in the laboratory should enable a person unfamiliar with the usual routine of the laboratory to escape in an emergency (or help combat it if appropriate). The laboratory PI is responsible for posting all applicable signs at the entrance way and inside for storage areas and equipment. Printable signs are available from the Laboratory Safety website.

Glassware Safety

Accidents involving glassware are a leading cause of laboratory injuries. Careful handling and storage procedures should be used to avoid breaking glassware. Adequate hand protection should be used when inserting glass tubing into rubber stoppers or corks or when placing rubber tubing on glass hose connections. Tubing should be fire polished or rounded and lubricated and hands should be held close together to limit movement of glass should fracture occur. The use of plastic or metal connectors should be considered. Glass blowing operations should not be attempted unless proper annealing facilities are available. Vacuum jacketed glass apparatus should be handled with extreme care to prevent implosions. Equipment such as Dewar flasks should be taped or shielded. Only glassware designed for vacuum work should be used for that purpose. Proper instruction should be provided in the use of glass equipment designed for specialized tasks, which can represent unusual risks for the first-time user. For example, separator funnels containing volatile solvents can develop considerable pressure during use and must be vented using proper technique. Glassware, which is to be heated, should be Pyrex or a similar heattreated type. Hand protection or a mechanical device should be used when picking up broken glass. Broken glassware should be disposed of in a special container marked "BROKEN GLASS".

Mercury Replacement

Chronic exposure to mercury can produce severe central nervous system damage. In its liquid form, mercury droplets will skate across horizontal surfaces and become lodged in minute cracks and crevices making spill cleanup very challenging. Mercury vapors are colorless, odorless, and highly toxic. Broken mercury-filled equipment is a common source of mercury exposure which can easily be prevented by substituting with nonmercury alternatives when possible. Contact the Safety and Risk Management Office if you have mercury containing equipment to be disposed of.

Maintenance Personnel and Housekeeping

Facilities Management, Housekeeping, and other support personnel may also be exposed to potential physical and chemical hazards in connection with work going on in the laboratory. They must be informed about the risks involved and educated about how to avoid potential hazards.

Use of Headphones and Earbuds in the Laboratory

The use of headphones or earbuds is prohibited in any lab that uses hazardous chemicals, biological organisms, or heavy machinery/equipment. The use of headphones or earbuds in the lab may prevent the lab worker from being fully aware of their surroundings and could cause a safety hazard to themselves or others in the lab. Handling headphones and earbuds in the lab may result in chemical contamination. The use of speakers or media devices that are speakers only (i.e. no earphones) are permitted at the discretion of the lab supervisor.

Section 11: Standard Operating Procedures (SOPs)

Written SOPs for any particularly hazardous substance (PHS) or procedures that pose unique health risks must be developed and made available for all lab members. The SOP describes how your lab will handle a hazardous chemical safely, including the amount and concentration you will use, how you obtain or create the working solution, special handling procedures, engineering controls, personal protective equipment, and waste disposal considerations. The SOP must be read, and signatures documented by all lab personnel who may be exposed to the hazardous situation. SOP templates are available from the Laboratory Safety website.

High Risk Procedures

High risk procedures are lab procedures which are likely to require engineering controls beyond those found in the standard laboratory. These include the use of chemicals or toxins which require medical surveillance, vaccination, special antidotes, or exposure monitoring, and operations that pose significant risk of fire, explosion, or exposure to personnel if a malfunction were to occur (such as a utility outage, runaway reaction, broken container, or chemical spill).

Contact the Safety and Risk Management Office (828-227-7443) if you have questions regarding High-Risk Procedures or if you need to obtain permission for any of the following procedures:

- Large quantities of liquid nitrogen or other cryogens which could deplete oxygen in the air. Large quantities would be more than one freezer and one attached Dewar per room, filling a cryocart or cooler, or liquid nitrogen (or other cryogen) piped in from a tank located outside the building.
- Heat concentrated perchloric acid (requires a perchloric acid approved fume hood).
- Use pyrophoric gases or other reactive Particularly Hazardous Substances (PHS).
- Use hydrofluoric acid or other chemicals for which an antidote or specific first-aid treatment is required.
- Use formaldehyde at the level which may require exposure monitoring or respirator use.
- Create or synthesize nanomaterials.
- Use botulinum toxin, tetanus toxin, or other toxins for which vaccination is recommended.
- Perform a procedure or use other equipment that is likely to require engineering controls beyond those found in the standard laboratory.

Section 12: Personal Protective Equipment (PPE)

Personal protective equipment is worn to minimize injuries and limit exposure to hazards in the workplace. It is important to understand the different types of personal protective equipment (PPE) available and to select the appropriate equipment for the circumstance. PPE must be available to assure a safe and healthful environment for all employees, students, and visitors.

Supervisors are required to assess the hazards and complete a PPE Hazard Assessment for their work area.

Eye Protection

Protective eye and face equipment shall be required where there is a reasonable probability of injury that can be prevented by such equipment. In such cases, employers shall make conveniently available a type of protector suitable for the work to be performed, and employees shall use such protectors. No unprotected person shall knowingly be subjected to a hazardous environmental condition. Suitable eye protectors shall be provided where machines or operations present the hazards of flying objects, glare, liquids, injurious radiation, or a combination of these hazards.

Required for Students: University policy on eye and face protection for students is derived from legislation enacted by the North Carolina General Assembly entitled "Policy for Eye and Face Protection," and passed in 1969. This Act requires that eye protective devices be worn by students in shops and laboratories where work involves:

- Hot solids, liquids, or, molten metals
- Milling, sawing, turning, shaping, cutting, or stamping of any solid materials
- Heat treatment, tempering, or kiln firing of any metal or other materials
- Gas or electric arc welding
- Repair or servicing of any vehicle
- Caustic or explosive chemicals or materials

Eye protective devices are always to be worn while participating in any of the above programs.

Required for Visitors: This act also provides that visitors to such shops and laboratories be furnished with and be required to wear eye safety devices while such programs are in progress.

Required for Employees: University policy on eye and face protection for employees is derived from the Occupational Safety and Health Act of North Carolina (OSHANC). The North Carolina legislation and OSHA NC specifies that eye and face protective devices, which include spectacles, goggles, and face shields, shall comply with American National Standards Institute (ANSI) Z87.1, 1979 and later revisions thereof. All eye and face protective devices currently on State Contract meet ANSI standards.

Selection of Appropriate Devices Based on Hazard: The type of device required will depend on the nature of the hazard and the frequency with which it is encountered. There are three basic types of eye protection which will meet the majority of university maintenance, shop, and laboratory requirements. These are: safety spectacles (with or without side shields), dust goggles, and chemical goggles. Each of these meet the basic eye protection standards for frontal exposure to flying particles.

<u>Safety Glasses:</u> At a minimum, safety glasses are required for all persons in the laboratory and must be worn where chemicals are used or stored. Lenses and frames shall be marked with the manufacturer's symbol to indicate compliance with ANSI Z87.1. The use of approved lenses in unapproved frames is not acceptable. Tinted lenses in safety glasses for minimizing solar glare are permissible only when used outdoors during daylight hours unless otherwise approved by the Safety and Risk Management Office. Prescription safety glasses can be worn by personnel whose vision requires the use of corrective lenses.

Side Shields: Safety glasses with side shields, or goggles, are required where flying particles are likely to enter at an angle and are usually required where two or more people are working in close proximity. Safety glasses with permanently attached side shields, or impact goggles, will provide this protection. Clip on side shields do not meet ANSI standards.

<u>Chemical Goggles:</u> Chemical goggles shall be worn to protect against dust particles, liquids, splash, mist, spray, and injurious radiation. They shall be designed to protect the eye sockets and the facial area around the eyes, thus protecting the wearer from side exposure. They can be worn over corrective eyeglasses if they do not disturb the adjustment of the glasses, or corrective lenses can be incorporated into the goggle by mounting behind the protective lens. Chemical goggles must be worn when:

- Performing a chemical transfer/handling operation
- Performing any other operations that have the likelihood for chemical splash or spray
- Working with glassware under reduced or elevated pressures
- Working with corrosive or hot liquids or fine particles capable of penetrating the ventilation holes in dust goggles
- Wearing contact lenses to prevent dissolved vapors and dust particles from creeping behind the lens. It is recommended that contact lenses are not worn where eye hazards exist.

<u>Face Shields:</u> Face shields shall be worn to protect the face and front of the neck from flying particles and sprays or splashes of hazardous liquids. Face shields must be worn in conjunction with appropriate eye protection devices and do not represent sufficient protection as a standalone device. Specialized eye protection is required for the following hazards:

- Welding and brazing operations
- Lasers
- Ultraviolet radiation
- Ionizing particulate radiation

Selection Based on Frequency of Use: Dust goggles are the least expensive approved eye protection device available, fit most head size and facial shapes, and may be worn over ordinary glasses. They are recommended for visitors, employees, and students who require eye protection periodically for short duration (less than two hours per day).

Adjustable safety glasses and prescription safety glasses are generally more comfortable than goggles and are therefore recommended for employees who require eye protection frequently or for long duration (more than 2 hours).

Photogray lenses (transition) will not be approved unless a medical need is certified by an eye professional. Photogray lenses will only be provided for employees needing eye protection whose job assignments are largely out of doors.

Contact Lenses: Contact lenses are not recommended for use where eye hazards exist because they do not protect the portion of the cornea they cover; furthermore, dissolved vapors, liquids, and dust particles tend to creep behind the lens.

Cost, Care, and Reclamation: The University is committed to a policy of providing eye and face protective device without cost to employees. Each department is responsible for funding its employee eye and face protection program. Departments may also furnish eye protective devices to students or may require students to purchase devices at the university bookstore. Visitors should be furnished with temporary eye protection without cost.

Eye Examinations and Prescription Frames: Scheduling and payment for eye examinations to obtain prescriptions and professional fittings for safety glasses are the responsibility of the employee and/or student. Frames and lenses for prescription and non-prescription safety glasses will be paid for by the University from a selection currently on a statewide contract. Only those items listed on the state contract will be furnished by the University.

Return of Protective Devices: Non-prescription eye protective devices issued to employees, students, and visitors remain the property of the University and are to be returned when the use of the devices is no longer necessary. For students, this will normally be at the end of each semester and for employees it will be on termination of employment or change in duties where eye protection is no longer required.

Replacement of Damaged Devices: Glasses damaged during normal wear and use may be replaced without charge to the employee or student at the discretion of the department head or designated administrative officer.

Replacing Lost Devices: Replacement of lost or stolen devices will be the responsibility of the employee or student to whom they were issued.

Cleaning Material: Eye protective devices are personal items and should be issued for the exclusive use of each individual. Materials for cleaning eye and face protective devices are to be made available to employees and students by each department. Eye protective devices must be thoroughly cleaned and disinfected before being issued to another person.

Eye Contamination: Every laboratory or workplace using caustic and/or corrosive chemicals shall be equipped with emergency eye wash facilities.

First Aid Chemical Burns: When the eye has received chemical irritation, the preferred first aid is to flood the eye with water immediately for at least 15 minutes and seek medical treatment as soon as possible. Neutralizers or other medication should be used only on the advice, or under the direction, of a physician.

Foot Protection

Closed-toed shoes should always be worn in laboratories or other areas where chemicals are used or stored. Perforated shoes, sandals, or cloth sneakers are not recommended to be worn in laboratories or areas where mechanical work is being done. Shoes are also required to be slip resistant with a tread pattern designed to give better traction and with a heel less than 1 inch high. Rubber or neoprene overshoes are designed to protect against splashing liquids or chemicals and may be necessary where gross contamination can occur.

Safety shoes are used to protect the feet against injuries from heavy falling objects, against crushing by rolling objects, or against lacerations from sharp edges. Safety shoes are required for employees whose job duties frequently require the lifting, carrying, or moving of objects weighing more than fifteen pounds, which, if dropped, would likely result in a foot or toe injury. The state personal protective equipment policy as of February 1, 1985, stipulates that employees who are required to wear safety shoes will be reimbursed up to a certain amount for one pair of shoes. For further information concerning employee eligibility for types of shoe protection, purchasing, etc., contact the Safety and Risk Management Office.

Hand Protection

Proper protective gloves should be worn when handling corrosive or toxic materials and materials of unknown toxicity, sharp edged objects, and very hot or very cold materials. Gloves should be selected based on the material being handled, the hazard involved, and their suitability for the operation being conducted. Glove materials are eventually permeated by chemicals; however, they can be used safely for limited time periods if specific use and glove characteristics (i.e., thickness and permeation rate and time) are known. Common glove materials include neoprene, polyvinyl chloride, nitrile, and butyl and natural rubbers. These materials differ in their resistance to various substances. Double gloving is recommended when handling highly toxic or carcinogenic materials. Before each use, gloves should be inspected for discoloration, punctures, and tears. Discolored, stiff, torn, or damaged gloves should be replaced immediately. Disposable gloves should be replaced when chemical contact occurs or when damage is suspected. Before removal, gloves should be washed if the material is impermeable to water. Remove gloves before you leave the lab and before handling objects such as doorknobs, telephones, or keyboards. Always wash hands after removing gloves.

Disposable Gloves: Disposable gloves are typically sufficient for incidental chemical contact. They are available in latex rubber, nitrile, polyethylene, PVC, neoprene, vinyl, and other synthetic materials. Latex is gradually being replaced by other suitable alternatives because of the latex allergy concern and should be avoided whenever a suitable alternative exists. Disposable gloves must be replaced following contamination or if visible damage occurs.

Chemical Resistant Reusable Gloves: The appropriate glove material must be selected that provides resistance to the specific chemical hazard that will be encountered, such as acids, alcohols, oils, corrosives, and solvents. Consult the chemical SDS as well as glove manufacturing guidelines when selecting chemical resistant gloves. Contact the Safety and Risk Management Office if further assistance is needed.

Cut-Resistant Gloves: When working with sharps and glassware it is important to protect your hands from cuts and scratches because broken skin is more susceptible to chemical exposure. It is recommended that in these situations, employees wear cut-resistant gloves over their chemical gloves.

Electrical Gloves: Rubber and leather insulating gloves, mittens, and sleeves are designed to protect the worker from electrical hazards such as fire ignition, electric shock, arc flash, and blast. The proper gloves shall be chosen in accordance with the NFPA 70E (2009) Standard for Electrical Safety in the Workplace and tested to appropriate voltage meeting ASTM D120-09 Standard Specification for Rubber Insulating Gloves.

It is best not to use gloves made either entirely or partly of asbestos, which is regulated as a carcinogen under OSHA. If you have asbestos gloves call the Safety Office so that they can be picked-up for disposal.

It is the responsibility of the laboratory supervisor to determine whether specialized hand protection is needed for any operation and to ensure that needed protection is available.

Lab Clothing and Protective Apparel

The clothing worn by laboratory workers can be important to their safety. Such personnel should not wear loose (e.g., saris, dangling neckties, and overlarge or ragged laboratory coats), skimpy (e.g., shorts and/or halter-tops), or torn clothing and unrestrained long hair (including long facial hair). Loose or torn clothing and unrestrained long hair can easily catch fire, dip into chemicals, or become ensnared in apparatus and moving machinery, and skimpy clothing offers little protection to the skin in the event of a chemical splash. Finger rings can react with chemicals and should be avoided around equipment that has exposed moving parts, or electrical hazards. If the possibility of chemical contamination exists, personal clothing that will be worn home should be covered by protective apparel.

Appropriate protective apparel is advisable for most laboratory work and may be required for some. Such apparel can include laboratory coats and aprons, jump suits, special types of boots, shoe covers, and gauntlets. It can be either washable or disposable in nature. Garments are commercially available that can help protect the laboratory worker against chemical splashes or spills, heat, cold, moisture, and radiation.

Always wear a lab coat when hazardous chemicals are in use. Laboratory coats are intended to prevent contact with dirt and minor chemical splashes or spills. Clothing may itself present a hazard (e.g., combustibility) to the wearer; cotton and synthetic materials such as Nomex or Tyvek are satisfactory; rayon and polyesters are not. Laboratory coats do not significantly resist penetration by organic liquids and, if significantly contaminated by them, should be removed immediately.

Plastic or rubber aprons provide better protection from corrosive or irritating liquids but can complicate injuries in the event of fire. Furthermore, a plastic apron can accumulate a considerable charge of static electricity and should be avoided in areas where flammable solvents or other materials could be ignited by a static discharge.

Disposable outer garments (e.g., Tyvek) may, in some cases, be preferable to reusable ones. One such case is that of handling appreciable quantities of known carcinogenic materials, for which long sleeves and the use of gloves are also recommended. Disposable full-length jump suits are strongly recommended for high-risk situations, which may also require the use of head and shoe covers. Many disposable garments, however, offer only limited protection from vapor penetration and considerable judgement is needed when using them. Impervious suits fully enclosing the body may be necessary in emergency situations.

Laboratory workers should know the appropriate techniques for removing protective apparel, especially any that has become contaminated. Chemical spills on leather clothing or accessories (watchbands, shoes, belts, and such) can be especially hazardous because many chemicals can be absorbed in the leather and then held close to the skin for long periods. Such items must be removed promptly and decontaminated or discarded to prevent the possibility of chemical burns.

Protective clothing worn on the job shall not be worn or taken away from the premises by employees, since this may expose other persons to unnecessary risk caused by contaminated clothing. The department will be responsible for cleaning and drying special clothing contaminated with or exposed to hazardous materials or for proper disposal in the event contaminated clothing needs to be discarded.

Respirators

In situations where the laboratory fume hood or local exhaust does not adequately prevent inhalation exposure, respirators may be necessary. Use of respirators requires medical clearance, annual training, and an annual fit test. Contact the Safety and Risk Management Office if you believe you may need a respirator so that exposure monitoring may be considered. The decision to conduct exposure monitoring will be based on the presence of over exposure indicators (such as odors or symptoms of exposure), the type and effectiveness of control measures in place, the amount of chemical used, and the hazards associated with that chemical.

Section 13: Guarding and Shielding for Safety

All mechanical equipment is to be equipped with guards that prevent access to electrical connections or moving parts, such as belts and pulleys of a vacuum pump. Each laboratory worker should inspect equipment before using it to ensure that the guards are in place and functioning. Careful design of guards is vital. An ineffective guard can be worse than none, because it may give a false sense of security. Emergency shutoff devices may be needed in addition to electrical and mechanical guarding.

Safety shielding is to be used for any operation having the potential for explosion such as (a) whenever a reaction is attempted for the first time (small quantities of reactants should be used to minimize hazards), (b) whenever a familiar reaction is carried out on a larger than usual scale (e.g., 5 - 10 times more material), and (c) whenever operations are carried out under non-ambient conditions. Shields are to be placed so that all personnel in the area are protected from the hazard.

Pressurized Systems

Heated reactions should never be carried out in an apparatus that is a closed system unless it is designed and tested to withstand pressure. Pressurized apparatus should have an appropriate relief device. If the reaction cannot be opened directly to the air, an inert gas purge and bubbler system should be used to avoid pressure buildup.

Cold Traps and Cryogenic Hazards

The primary hazard of cryogenic materials is their extreme coldness. The surfaces they cool can cause severe burns if allowed to contact the skin. Gloves and a face shield may be needed when preparing or using some cold baths. 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 leading to an explosion hazard. Appropriate insulated gloves should be used when handling dry ice. Dry ice should be added slowly to the liquid portion of the cooling bath to avoid foaming over.

Section 14: Laboratory Security Awareness

Attacks on the United States with biological and chemical weapons is an increasing concern and academic laboratories are a potential target for individuals wanting access to explosive precursor materials, biological toxins, and equipment. This information is intended to raise awareness for potential chemical and biosecurity risks in academic labs and actions we can take to report suspicious behavior and mitigate potential issues. Use the following guidelines to help identify suspicious behavior and enhance chemical security awareness in university laboratories:

- Be aware of unknown individuals trying to access the lab or requesting to borrow chemicals or equipment.
- Maintain a chemical and equipment inventory and be aware of missing supplies or chemicals.
- Let your supervisor know if you receive a request from an unidentified person asking questions about scientific processes or other technical information. Be aware of emails that look like they are associated with legitimate entities (@edu.com or @edu.us).
- Use an ordering system to quickly identify any purchases that are charged to the lab but never delivered, or items delivered that don’t have a corresponding lab purchase order.
- Always lock the lab when it is unoccupied, even if only leaving for a short time (i.e. phone call, bathroom or eating break, etc.).
- Mention any suspicious activity to your lab supervisor.

Report Suspicious Activities:
WCU Department Head

WCU Campus Police 828-227-8911 (emergency), 828-227-7301 (non-emergency)
WCU Safety and Risk Management Office: 828-227-7443

Section 15: Laboratory Chemical Waste Management

As a generator of hazardous waste, the University is required to comply with Federal Standards promulgated under the Resource Conservation and Recovery Act (RCRA). These regulations cover the storage, handling, and documentation of the transfer of hazardous waste from the point of generation to the final disposal.

Laboratory areas on campus are required to follow the waste management policies detailed in WCU's **Laboratory Waste Management Plan (LWMP)**. The purpose of the Laboratory Waste Management Plan (LWMP) is to comply with the provisions of 40 CFR 262 (Subpart K – Alternative Requirements for Hazardous Waste Determination and Accumulation of Unwanted Material at Laboratories Owned by Colleges and Universities and Other Eligible Academic Entities Formally Affiliated with Colleges and Universities).

Laboratory Waste Management Plan

The Laboratory Waste Management Plan applies only to laboratories on campus including:

- Teaching Labs
- Research Labs
- Visual Art & Design Studios
- Theatrical Studios
- Photography Studios
- Research Field Labs
- Diagnostic Labs
- Areas that support labs such as chemical stockrooms and prep rooms

Hazardous Waste Training

All laboratory personnel are trained on chemical waste management procedures via an online training presentation and quiz. This training is administered by the Safety and Risk Management Office.

In addition, the PI specific lab SOPs cover chemical waste management and must be reviewed annually. If chemical waste issues are found during laboratory inspections the lab will be asked to take a refresher training to ensure future compliance.

Section 16: Laboratory Training Requirements

Safe use of hazardous materials requires knowledge of risks to the researcher, campus community, and environment. Researchers learn to handle hazardous materials safely during their scientific training and experience, as well as through information and training provided by their supervisors and the University's Safety and Risk Management Office. Principal Investigators and Lab Supervisors must ensure that their personnel receive appropriate safety information and training.

General Lab Safety Training: Each laboratory employee is required to take the general laboratory safety course before beginning work in the lab and every two (2) years thereafter or following any significant change. Other courses will be assigned based on a Hazard Risk Assessment Training Determination Form that is submitted for each lab employee. This training is administered by the Safety and Risk Management Office.

Laboratory Specific Safety Training: The lab supervisor shall conduct laboratory-specific hazard awareness training for each employee or student working in the lab before that person begins work. This hazard awareness training must be documented and shall be reviewed and updated any time a new hazard is introduced in the laboratory.

Section 17: Facility Design

Furniture Selection

The following guidelines should be used when selecting new furniture for laboratories. If there is a question on furniture selection, contact the Safety and Risk Management Office. No furniture used in laboratories that has been exposed to corrosive, toxic, or flammable chemicals or biological hazards may be repurposed for use in an office setting. Furniture that is no longer needed must be disposed of or relocated to another laboratory that its design and construction is suitable for.

Casework Materials:

- Metal or hardwood (such as oak or other approved equivalent) may be used in general research and teaching laboratories where humidity and temperature will be normal (standard for occupied rooms), and where biohazardous, flammable, corrosive, or toxic substances will not be absorbed into the surface.
- Plastic laminate may be used in miscellaneous storage and workrooms requiring base or wall storage facilities, and where the infusion of appropriate colors may be architecturally desirable.
- Only non-combustible and non-reactive chemical resistant laminates and resins may be used where biohazardous, flammable, corrosive, or toxic chemicals are to be used or stored.
- Millwork shall not be considered for new construction. Variances may be considered on renovation projects on a case by case basis.

Counter Tops:

Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
Composition Stone with a chemical resistant resin finish	Natural Quarry Stone with a chemical resistant resin finish	Solid Resin for chemical resistant surfaces	Wood fiber or wood particle board core, with chemical resistant	Plastic Laminate with a wood particle core; may be self-edged or	Stainless Steel. Type 316 polished stainless steel,	Composition Stone with a low gloss vinyl sealer

			finish on all exposed surfaces	post-formed	approved on a case-by-case basis.	

Chemical Reaction and Abuse Resistance:

Type 1: Composition Stone with a chemical resistant resin finish

Type 2: Natural Quarry Stone with a chemical resistant resin finish

Type 3: Solid Resin for chemical resistant surfaces and in the bottom of general-purpose fume hoods.

General Purpose Areas where neither chemical nor physical abuse is expected and where no liquids or biological hazards are to be used (such as writing surfaces, instrument support surfaces, or storage areas) shall use either of the following:

Type 4: Wood Core, a wood fiber or wood particle board core, with chemical resistant finish on all exposed surfaces

Type 5: Plastic Laminate with a wood particle core; may be self-edged or post-formed.

Radiation and Other Special Uses: Areas where radioactive materials or other special uses are approved shall use the following:

Type 6 – Stainless Steel – Type 316 polished stainless steel countertop surfaces may be approved on a case-by-case basis.

Physical Abuse Resistance: Areas where abrasive physical abuse is expected; Physics, Earth Sciences, Geology shall use:

Type 3 – Solid Resin with a chemical resistant surface, or

Type 7 – Composition Stone with a low gloss vinyl sealer

Fume Hood Work Surfaces:

General Purpose Hoods – Type 3: Solid Resin (chemical resistant)

Radiation Hoods – Type 6: Type 316 Stainless Steel

Perchloric Acid Hoods – Type 6: Type 316 Stainless Steel

Special Purpose Hoods – Type 3, Solid Resin (chemical resistant)

Chairs: Laboratory seating should be upholstered with vinyl or be constructed of solid materials such as plastic or wood that has been sealed to render it non-porous. Finishes shall be as resistant as possible to the corrosive chemical activity of chemicals used in the laboratory, as well as disinfectants.

Natural or synthetic fabric upholstery is not acceptable for use in a laboratory.

Chairs for working at laboratory benches, computer workstations, or biological safety cabinets should have the following adjustments:

- Pneumatic height adjustment
- Adjustable lumbar support

- Adjustable foot ring
- Adjustable seat pan depth

If the chair has arms, the arms should have the following adjustments:

- Adjustable height arms (small “T” style)
- Adjustable arm width

Furniture and Equipment Surplus or Disposal

Review the Laboratory Waste Management Plan (LWMP) section for Laboratory Equipment Disposal and Surplus Property. The University has procedures in place to ensure the safety of personnel picking up surplus equipment as well as requirements to ensure the proper disposal regulations are followed.

Section 18: Laboratory Ventilation

Engineering controls are designed to protect workers from hazardous conditions by placing a barrier between the worker and the hazard or by removing the hazardous substance through air ventilation.

Chemical Fume Hoods

Chemical fume hoods (CFHs) are the primary containment device in the laboratory used to control airborne contaminants generated by experimental procedures. Use a chemical fume hood when working with:

- Powdered particularly hazardous substances (PHSs)
- Any volatile compounds and chemicals with a strong odor
- Other materials as indicated by the lab specific SOP or chemical SDS

Chemical fume hoods provide personnel protection by means of directional airflow from the laboratory into the hood through the face opening. This airflow reduces the potential for escape of airborne contaminants into the laboratory. Procedures involving volatile chemicals and those involving solids or liquids that may result in the generation of toxic vapors should be conducted in a chemical fume hood rather than on the open bench. Placing a reacting chemical system within a hood, especially with the hood sash closed, places a physical barrier between the workers in the laboratory and the chemical reaction. This barrier can afford laboratory workers protection from chemical splash, sprays, fires, and minor explosions.

Hoods should be evaluated before use to ensure adequate face velocities. Hoods are checked by the Safety & Risk Management Office to determine the face velocity. An adequate face velocity for most applications is 100 feet per minute ± 10%. Hoods with low face velocity <75 feet per minute are posted as "low toxics only" use.

Although chemical fume hoods do protect laboratory personnel from exposures to hazardous materials, they must be used properly to maximize their effectiveness.

Fume Hood Best Practices

- Avoid creating air currents or cross-drafts across the hood face
- Foot traffic, local ventilation systems, windows and doors may cause air currents to form across the hood face, which may reduce the hood performance and pull contaminated air out of the hood toward the user. Restrict foot traffic and rapid arm/body movement around the hood face. Keep lab doors and windows closed unless lab ventilation design requires them to be open.
- Take extra precautions when handling electrical equipment & flammables in a fume hood
- Do not use a spark source when flammable liquids or gases are present inside the hood. Permanent electrical receptacles are not permitted in the hood.
- Perform work with the sash height below the appropriately marked position
- The appropriate 18-inch closure point should be clearly labeled on the outer frame of the sash. The sash should remain fully closed with the hood exhaust operating when the hood is unattended.
- Minimize the amount of materials & equipment in the hood and avoid using as storage
- Equipment placed in the hood may restrict adequate exhaust airflow. If it is necessary to have equipment in the hood, position it towards the back of the hood and elevate with blocks to maintain an airflow gap and enhanced air circulation. Only chemicals necessary to perform the experiment should be left in the hood, all other chemicals should be stored in approved safety storage cabinets. Do not store waste containers in the hood.
- Keep the hood exhaust baffles unobstructed and appropriately adjusted
- The bottom slot should be wide open, and the top slot fully or partially closed to allow airflow across the workbench where heavier than air solvent vapors congregate.
- Do not modify any part of the hood or ductwork
- Do not drill holes for gas tubing or modify the fume hood in any way. The hoods are specially designed for airflow specifications and any alterations will disrupt the flow and void the manufacturer warranty.
- Place chemical sources & equipment at least 6 inches behind the sash opening
- Placing a line of tape across the work surface at this 6-inch mark inside the fume hood from the hood sash will help as a reminder.
- Handle perchloric acid only in a designated perchloric acid fume hood
- Water wash-down fume hoods made of noncombustible material must be used for perchloric acid. If there is a doubt as to whether the wash-down system is functioning properly, stop all work in the hood and call the Safety and Risk Management Office for inspection/repair.
- Do not use a hood to evaporate hazardous chemicals or as a means of chemical disposal
- All chemicals inside the hood must remain capped when not in use.
- Wear appropriate Personal Protective Equipment (PPE) when working with chemicals
- At a minimum wear eye protection, gloves, and a lab coat when working with hazardous chemicals in the hood. Consult the Safety Data Sheet (SDS) for appropriate PPE.
- If the hood is not working, post an “OUT OF SERVICE” sign
- Do not work in the hood and contact the Safety and Risk Management Office.

Fume Hood Repairs

Most laboratories handle hazardous materials which can generate harmful concentrations of aerosols, fumes, and vapors within the fume hood exhaust air and which can contaminate the surfaces of laboratory equipment. It is essential for the safety of those required to repair fume hood fans and motor equipment that appropriate precautions be taken to prevent exposure to air contaminants and laboratory equipment is decontaminated prior to service. Whenever work is performed on roof vent fans, within fume hood enclosures, or on laboratory equipment the following procedures must be followed:

Roof Fans: Prior to starting work laboratory personnel must certify that all sources of harmful aerosols, fumes, and vapors are contained or removed from the hood being serviced and any additional hoods using the same ductwork.

- Wear neoprene gloves when performing work within the duct air stream enclosure.
- Lock and Tag all switches operating the hood fan while conducting maintenance.

Hood Enclosures: Prior to starting work all materials must be removed from the hood enclosure and contaminated surfaces (if any) shall be cleaned by laboratory personnel.

Laboratory Equipment: Prior to starting work all containers of hazardous materials must be removed and all potentially contaminated surfaces cleaned by laboratory personnel. A radiation survey is to be done for any equipment which has been used with radioactive materials.

Plumbing: Chemical containers stored around plumbing drains or fixtures must be removed by laboratory personnel. If possible, flush the drains with plenty of water. Maintenance employees must wear neoprene gloves and chemical goggles. Fume hood manuals are available from the Safety and Risk Management Office.

Fume Hood Failure

For a variety of reasons, whether it is an electrical problem, mechanical problem, or routine maintenance, a fume hood malfunction can occur. If a low airflow alarm should signal or if personnel recognize there is low or no airflow from the fume hood; these outlined procedures should be followed:

- Immediately stop all work inside the fume hood.
- If safe to do so, secure, or isolate reactions, turn off all equipment being used (hot plates, burners etc.), and close all open chemical containers.
- Close the sash completely.
- If processes or reactions that could create a hazard to the lab or building occupants cannot be stopped or contained, the lab(s) or possibly the building should be evacuated until the hazard is eliminated. Activate the Fire Alarm. Evacuate the building and wait for emergency personnel to arrive. Inform emergency personnel of the situation.
- During a power outage turn off or unplug other electrical equipment which could turn on once the power is restored.
- Report the problem immediately to your lab manager or to the Safety and Risk Management Office.

- Notify others in the area or anybody who could use the fume hood later.
- Hood(s) that have malfunctioned should have a sign posted to inform that the hood is not functioning correctly and may not be used until repairs have been made. Signs posted should state "FUME HOOD OUT OF SERVICE - DO NOT USE". Sign(s) will be installed by either the personnel who discover the fume hood problem or by the Safety and Risk Management Office.
- Do not use the fume hood until the posted sign has been removed. Only the Safety and Risk Management Office will remove any posted sign. Once the sign has been removed the department or lab manager will then be notified of completed repairs.

Local exhaust

Local exhaust systems can be used when there is a localized source of chemical vapors that can be captured. Examples include snorkel type exhaust and down draft sinks. Isolation devices are often sealed plexiglass boxes and can be combined with local exhaust to offer physical separation to a contaminant generating process.

Biological Safety Cabinets (BSCs)

Biological Safety Cabinets or Biosafety Cabinets are primarily intended to protect employees from biological hazards and should not be used for chemical hazards. A detailed description for the use of BSCs is provided in the University Biosafety Manual.

Section 19: Laboratory Safety Equipment

Eyewashes and Safety Showers

OSHA (29 CFR 1910.151) requires that, "where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate use. Employee perceptions about causing property damage must not delay use of emergency equipment.

- All emergency eyewash and shower equipment shall conform to and be installed in accordance with the requirements listed in ANSI/ISEA Z358.1 (most recent revision), *American National Standard for Emergency Eyewash and Shower Equipment,* developed with the International Safety Equipment Association (ISEA).
- Devices must deliver tepid water (60-100°F).
- Devices must be installed in a location and configuration so that they are protected from contamination and do not present additional hazard during use (location cannot expose the user to electrical hazards, sharp edges, etc.)
- Eyewash placement:
    - Nozzles must be installed at least 6 inches from the wall (or nearest obstruction)
    - Nozzles must be located 33-45 inches in height above the surface on which the user stands.
- Shower placement:
    - The valve actuator for showers shall be within 69 inches of the surface on which the user stands.

    - The top of the water column shall be between 82 and 96 inches from the floor with the center of the spray at least 16 inches from any obstruction.
- When large quantities (greater than 1 gallon) of corrosive or toxic materials are present, combination safety showers and eyewash stations are necessary and must be installed where they require no more than 10 seconds to reach.
- Personnel must be made aware of the location and operation of the eyewash and safety shower stations. Even the best emergency products won't be able to serve their purpose if employees are unaware of where they are or how to use them.

Eyewash and Shower Inspections

The lab personnel are responsible for ensuring that emergency eyewash facilities are operational and accessible. Eyewash stations that have a plumbed drain should be flushed weekly and documented on an attached sheet or tag. If, due to their configuration or location, eyewashes do not have an accessible plumbed drain, the eyewash must be checked at least monthly with a quick activation to flush out any debris and verify water pressure. The monthly check must be documented on an accessible sheet or an attached tag. For facilities that lack floor drains, secondary containment should be used to prevent discharge of water directly onto the floor. Safety showers will be flushed and maintained by the Safety and Risk Management Office. Report any problems to the Facilities Management department.

During the annual inspection of emergency safety showers, the Safety Office shall:

- Ensure the path to the equipment is not obstructed, is in a well-lit area, and is identified by a highly visible sign.
- Inspect components for corrosion and damage.
- Verify nozzle caps are in place and that nozzles, nozzle caps, and bowl/sink are clean and sanitary.
- Activate valve to fully open position. Water must flow within 1 second.
- Verify nozzle caps come off when eyewash is activated.
- Verify the water flows continually hands-free until manually turned off.
- Flush until water is clear.
- Put nozzles back in place.
- Annually: Safety Office will perform a flow test. Flow must be at least 3 gallons per minute for eyewashes and 20 gallons per minute for showers. Ensure temperature is within the required range.

Fire Extinguishers

Since fire is a common hazard that one faces in a science and engineering laboratory, it is important to be prepared and to know how to deal with a fire emergency. Fire extinguishers are a first line of defense, only if used properly, and under the right conditions. Fire extinguishers are appropriate for small, incipient stage fires, no bigger than a wastepaper basket. University policy states that individuals are not required to fight fires, but that those who choose to do so must have been trained in the proper use of fire extinguishers. Training is provided by the Safety Office to faculty and staff upon request. Students are discouraged from attempting to use fire extinguishers and are not offered training on their use. Fires are classified based on the type of fuel that is burning, and fire extinguishers are classified based on the type of fire they are designed to extinguish.

- Class A – Wood, paper, cloth, trash, and plastic (solid combustible materials that are not metals)
- Class B – Flammable liquids
- Class C – Electrical equipment
- Class D – Combustible metals such as magnesium, potassium, and sodium, as well as organometallic reagents such as alkyl lithium, and diethylzinc
- Class K – Cooking media such as vegetable oil and grease

Labs have been provided with Class ABC Dry Chemical extinguishers. Labs using potentially flammable metals should contact the Safety Office to obtain an appropriate Class D extinguisher. Any time an extinguisher needs to be utilized, the Safety Office must be notified to collect information about the incident and provide a new extinguisher.

Fire-Rated Doors

A fire-rated door is made of fire-resistant materials which when closed prevents the spread of fire and smoke through fire rated walls. Any time a doorway to a room, exit stairwell, or exit pathway is propped open by use of an unapproved device such as a wood or plastic wedge, or the latching door hardware is bypassed by taping, the fire-rated area is now compromised. To minimize the break in protection, fire doors, including the closer and latching hardware must not be modified by building occupants and must be kept closed.

Section 20: Emergency Preparedness and Response

The University provides non-emergency and initial emergency response services through Campus Police, the Safety and Risk Management Office, and Facilities Operations. Campus Police provides 24/7 coverage and will contact specific resources as needed. A list of contact numbers is provided in Appendix A and should be posted in a visible area of your work space. For non-emergency services during normal business hours, contact the appropriate department.

Where a response will be needed at the time of an emergency, a written plan describing the actions that are to be taken and an emergency contact list for laboratory employees must be encompassed in the laboratory specific documentation by the Supervisor or PI.

Types of Incidents:

Each lab should consider the types of incidents that could have a negative effect on people, property, the environment, and research efforts and participate in planning efforts to mitigate the impact of an emergency and the required response for each situation (i.e. backup power for critical lab equipment).

- For emergencies that may impact building integrity and/or harm people, evacuate the immediate area and call 911.
- For other incidents/accidents that do not pose immediate danger to people or the environment, call the Safety and Risk Management Office to report the incident and illicit assistance as needed.

- If maintenance support is required, contact Facilities Management.

Chemical Spill Response

In the event of a chemical spill, protection of personnel should be the primary concern, then protection of property. Many laboratory spills are of limited hazard potential and laboratory personnel can clean them up safely. Your laboratory should be equipped to handle small low-hazard spills. Spill kits with appropriate instructions, PPE, and absorbents must be available in the lab so that laboratory employees may safely clean up minor chemical spills. It is the responsibility of the PI to ensure that it is stocked with needed supplies, and that all employees know where the kit is located and how to use it. Laboratory employees should be familiar with the hazards of the chemicals they work with and should have a sense of the need for spill clean-up assistance from the Safety Office.

Chemical Spill Kit: Every area where chemicals are stored or in use should have access to a chemical spill kit for minor spills. The spill kit should include the following:

- Absorbent material (vermiculite, absorbent pads, etc.)
- Neutralizers for corrosives or toxics
- Materials to limit the flow of a spill (absorbent sock/boom)
- PPE (gloves, safety goggles)
- Container/bags to collect the hazard spill contents
- Hazard waste tag/label to identify the contents

Minor Chemical Spills can be handled by laboratory staff without assistance following these general guidelines:

- Avoid breathing vapors from the spill
- Alert people in the immediate area of the spill
- If spilled material is flammable turn off ignition and heat sources
- Reference the SDS for appropriate PPE, spill response, and first aid measures
- Put on all appropriate PPE
- Confine spill to small area
- Use appropriate kit to neutralize and absorb acids and bases
- Use appropriate kit or spill pads for other chemicals
- Collect residue, place in appropriate container, label and dispose as chemical waste
- Clean spill area with water

Some spills may be more hazardous, and personnel should not attempt cleanup. You should evacuate the room and call the Safety and Risk Management Office (828-227-7443) if a spill situation involves any of the following:

- a respiratory hazard
- a threat of fire or explosion
- more than 100 mL of an OSHA regulated chemical carcinogen or a highly toxic chemical
- more than 1 liter of a volatile or flammable solvent

- more than 1 liter of a corrosive (acid or base) liquid
- elemental (liquid) mercury spills

Major chemical spills

There may be little time to shut down procedures and secure activities and materials, so initial procedures should be to close containers and contain the spill if possible and initiate evacuation.

- Alert people in the area to evacuate
- If spilled material is flammable turn off ignition and heat sources
- Call 911 and notify the Safety and Risk Management Office (x7443)
- Attend to contaminated persons and remove them from exposure
- Have a person knowledgeable of the area assist the emergency personnel

Provide the following information when calling for assistance with a chemical spill:

- Caller's name and phone number
- Location of the incident
- Location to meet the caller if they have to evacuate the premises
- Identity and quantity of the material spilled, if known, and any odors present
- Any injuries

The University is required to report any "reportable quantity" releases of hazardous chemicals to the environment, such as releases of compressed gases, outdoor spills, and discharges to the sewers. The Safety Office must be notified immediately of any release to the environment to ensure that the appropriate notifications are made.

Chemical Exposure

Chemical spill on the body:

- Flood exposed area with running water for at least 15 minutes. If in eyes, rinse eyeball and inner surface of eyelid with water, forcibly holding eye open to effectively wash behind eyelids.
- Remove all contaminated clothing and shoes.
- If medical attention is needed, proceed to campus Health Services for medical care. Provide medical professionals with SDS sheets to ensure proper first aid and diagnosis. If immediate medical care is needed call 911.
- Report the incident to supervisor and complete a Report of Work-related Accident, Injury, or Illness.

Antidotes

Some chemicals have acute exposure effects that may be relieved or minimized by an antidote (i.e. calcium gluconate gel is to be used for first aid in the case of a hydrofluoric acid burn.) Using an antidote does not negate the need to seek medical attention immediately. Refer to SDS information to know if antidotes need to be stocked in the lab, or contact the Safety and Risk Management Office. Periodically check the expiration date for the antidotes stocked in the lab to ensure that they will be effective if needed.

Reporting Accidents

The University has incident reporting procedures in place to comply with federal and state regulations. Incidents resulting in personal injuries to employees, students, and visitors while on University property, or during University employment or activity off campus, must be reported to the Safety and Risk Management Office within 24 hours.

Near miss incidents which do not result in an injury or illness but could have under slightly different circumstances should also be reported to the Safety and Risk Management Office. Reporting a near miss allows us to determine how and why it occurred and to take action to prevent a similar, or more serious, incident from happening in the future.

Appendix A: Emergency Contacts

In the event of an emergency affecting campus, the Campus Emergencies webpage is the official source for WCU emergency related information.

Emergency Telephone Numbers

	Normal Business Hours	**Evenings/Weekends**
EMERGENCY Fire/Police/Medical	828-227-8911 or 911	828-227-8911 or 911
University Police Department NON-EMERGENCY	828-227-7301	828-227-7301
Safety and Risk Management	828-227-7443	828-227-7443
Chemical Spill	828-227-7443	828-227-7443
Biological Spill	828-227-7443	828-227-7443
Radiation Exposure	828-227-7443	828-227-7443
Workers' Compensation	828-227-7443	828-227-7443
NC Poison Control Center	1-800-84 TOXIN (1-800-848-6946)	1-800-84 TOXIN (1-800-848-6946)
N.C. Radiation Protection Section	919-814-2250	800-858-0368 Emergency after hours
Jackson County Department of Public Health	828-586-8994	8:00am - 5:00pm Monday-Friday
Work Management Centers		
Facilities Management	828-227-7442	828-227-7224
WCU Health Services	828-227-7640	828-227-8911 EMS