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I. Purpose

North Carolina Central University (NCCU) is committed to providing a safe and healthful environment for all persons including staff, students, visitors, and the surrounding community. Personnel conduct a vast array of research utilizing hazardous materials on the campus.

This manual provides basic information about hazards that may be encountered in the laboratory and safety precautions to prevent laboratory accidents and minimize exposure to hazardous chemicals, environmental issues, biological materials, and infectious agents.

II. Emergency Contacts

<table>
<thead>
<tr>
<th>Agency</th>
<th>Phone</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Health &amp; Safety</td>
<td>919-530-7125</td>
<td>8:00 a.m. – 5:00 p.m</td>
</tr>
<tr>
<td>University Police</td>
<td>919-530-6106 or 911</td>
<td>24 hours</td>
</tr>
<tr>
<td>Work related injuries</td>
<td>919-530-6106 or 911</td>
<td>24 hours</td>
</tr>
<tr>
<td>Fire or Smoke</td>
<td>919-530-6106 or 911</td>
<td>24 hours</td>
</tr>
<tr>
<td>NC Poison Control</td>
<td>1-800-84 TOXIN (1-800-848-6946)</td>
<td>24 hours</td>
</tr>
<tr>
<td>Gas Leaks or Odors</td>
<td>919-530-7125</td>
<td>8:00 a.m. – 5:00 p.m</td>
</tr>
<tr>
<td></td>
<td>919-530-6106 or 911</td>
<td>24 hours</td>
</tr>
<tr>
<td>Physical Plant</td>
<td>919-530-6392</td>
<td>8:00 a.m. – 5:00 p.m</td>
</tr>
<tr>
<td>Chemical Spills</td>
<td>919-530-7125</td>
<td>8:00 a.m. – 5:00 p.m</td>
</tr>
<tr>
<td></td>
<td>919-530-6106 or 911</td>
<td>24 hours</td>
</tr>
</tbody>
</table>

III. Responsibilities

While Environmental Health and Safety (EHS) has administrative responsibility for the laboratory safety program, everyone involved in laboratory operations – from the highest administrative level to the individual laboratorians – must be part of the safety culture. A positive safety culture is built on empathy.
and compassion and strives to encourage high quality, safe research. A positive safety culture does not blame or reprimand others, rather laboratorians recognize that administrators and faculty place their well-being above all.

Everyone involved in laboratory work has a responsibility to themselves and to colleagues to plan and execute laboratory operations in a safe manner. Specific responsibilities which will foster research and ensure safety and compliance are assigned to each group.

A. Department Chair

1) Ensure department’s compliance with health and safety standards.
2) Provide timely notification to EHS upon termination of faculty who used hazardous materials, to expedite safe clearance of the laboratory

B. Principal Investigator

1) Prepare a Laboratory-Specific Safety Plan which along with the NCCU Chemical Safety Plan constitutes the Chemical Hygiene Plan as required by OSHA.
2) Ensure that laboratory personnel meet all laboratory safety training requirements.
3) Ensure that all laboratory workers submit a NCCU Laboratory Worker Registration Form at hire and whenever there is a change in work location or laboratory assignment.
4) Work with laboratorians to ensure completion all required initial and annual training. Submit the NCCU Laboratory Training Record for approval within 30 days of hire to document the initial training.
5) Ensure that staff and visitors observe safety rules and don proper personal protective equipment (PPE) when working in or visiting the laboratory.
6) Ensure that proper safety supplies and equipment, such as gloves, safety glasses and/or goggles, lab coats, etc. are available for all people in the laboratory.
7) Train staff on location of safety data sheets for hazardous chemicals used in the laboratory
8) Keep accurate laboratory chemical inventory.
9) Post appropriate hazard information signs at entrance and within the laboratory.
10) Conduct an “exit interview” with laboratory workers prior to their departure to ensure that they have properly labeled and prepared hazardous materials for disposal by EHS or use by other workers.
11) Complete and submit the Laboratory Exit Checklist prior to vacating laboratory space due to departure or move.
C. Laboratory Workers

1) Submit a [NCCU Laboratory Worker Registration Form](https://nccu.edu/ehs) to EHS at hire and whenever there is a change in work location or laboratory assignment.

2) Familiarize yourself with this [Laboratory Safety Manual](https://nccu.edu/ehs) and your Laboratory-Specific Safety Plan.

3) Work with PI or designee to complete all required initial and annual training. Submit the [NCCU Laboratory Training Record](https://nccu.edu/ehs) to EHS for approval within 30 days of hire.

4) Follow safety guidelines when handling hazardous materials, including proper use of personal protective equipment.

5) Notify EHS of accidents, spills, or conditions that may warrant further investigation and/or monitoring.

6) Review laboratory materials to ensure that you have properly labeled and prepared all hazardous materials for disposal by EHS or use by other workers before you leave the research group.

D. Environmental Health & Safety

1) Retain delegated authority to enforce safety and compliance on campus (Appendix A)

2) Provide and document training for laboratory personnel.

3) Inspect laboratories at least annually for safety and health hazards and for compliance with state and federal regulations.

4) Investigate potential safety and health hazards.

5) Monitor personnel as needed for chemical, biological, and physical hazards.

6) Advise laboratory personnel on proper disposal of waste and other hazardous materials.

7) Consult with faculty, staff, students, and University Safety Committee on safety matters.

IV. Requirement for Laboratory-Specific Safety Plan

While this Laboratory Safety Manual covers policies and procedures common to laboratories across campus, each principal investigator must prepare a Laboratory-Specific Safety Plan for their lab which addresses the hazards and precautions specific to the laboratory. NCCU provides a [Laboratory Specific Safety Plan template](https://nccu.edu/ehs) for use by individual laboratories.

The OSHA document, [29 CFR 1910.1450 Laboratory Standard](https://osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9777&ga=2212), requires that where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan (CHP) to help protect people working in a laboratory setting.

At NCCU, each laboratory’ CHP consists of the Laboratory-Specific Safety Plan and the NCCU Chemical Safety Plan. The CHP must be readily available to employees, employee representatives and, upon request, to
inspectors. The components of a CHP mandated by the Laboratory Standard are listed below along with the location.

<table>
<thead>
<tr>
<th>Component</th>
<th>Plan(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab-specific standard operating procedures involving the use of hazardous chemicals</td>
<td>Lab-Specific Safety Plan</td>
</tr>
<tr>
<td>Criteria used to determine and implement control measures</td>
<td>Lab-Specific Safety Plan</td>
</tr>
<tr>
<td>Requirements to ensure that control measures perform properly</td>
<td>NCCU Chemical Safety Plan</td>
</tr>
<tr>
<td>Training requirements and required training documentation</td>
<td>NCCU Chemical Safety Plan</td>
</tr>
<tr>
<td>Medical consultation and examinations required</td>
<td>NCCU Chemical Safety Plan</td>
</tr>
<tr>
<td>Designation of chemical hygiene officer</td>
<td>NCCU Chemical Safety Plan</td>
</tr>
<tr>
<td>Requirements for handling particularly hazardous chemicals</td>
<td>NCCU Chemical Safety Plan</td>
</tr>
<tr>
<td>Identification of designated areas (laboratories, storage rooms, disposal areas)</td>
<td>NCCU Chemical Safety Plan</td>
</tr>
<tr>
<td>Containment equipment necessary</td>
<td>NCCU Chemical Safety Plan</td>
</tr>
<tr>
<td>Procedures for safe removal of hazardous waste</td>
<td>NCCU Chemical Safety Plan</td>
</tr>
<tr>
<td>Laboratory cleaning protocols</td>
<td>Lab-Specific Safety Plan</td>
</tr>
</tbody>
</table>

V.  Documents Available to Laboratory Personnel

In addition to this Laboratory Safety Manual, the following documents must be available to and/or reviewed by laboratory personnel as applicable. Review should occur with new staff before allowing them to perform work in the laboratory and annually thereafter.

- NCCU Biosafety Manual
- NCCU Chemical Safety Plan
- Laboratory-Specific Safety Plan
- Access to online or printed Safety Data Sheets (SDS) for chemicals in laboratory

If applicable, the Principal Investigator must also make the following documents accessible within the laboratory or online.
• Exposure Control Plan
• Greenhouse Biosafety Plan
• Laser Safety Manual
• Purchase and Storage of Tax-Free Pure Ethanol for Laboratory Use
• Respiratory Protection Plan

Each laboratory worker must be familiar with the contents of plans and manuals that pertain to their workplace and the procedures for obtaining additional safety information needed to perform their duties safely. A hard copy is not required as long as laboratorians have access to the online version in their place of work.

VI. Training

Successful completion of the New Employee Orientation for the Laboratory Environment by EHS is required for all new laboratorians or lab staff. Completion requires a score of 80% or greater on the assigned quiz.

Within the first 30 days of employment new personnel must complete all NCCU and lab-specific required training and submit the NCCU Laboratory Training Record to EHS.

As required by regulation, EHS will provide necessary refresher training and documentation to all laboratorians that includes components of chemical safety, biological safety, fire and life safety, and other more targeted trainings.

VII. Recordkeeping

OSHA regulations require maintenance of monitoring and medical records for a period of thirty years following termination of employment. EHS maintains the following records:

• Copies of retired Laboratory-Specific Safety Plans
• Retired NCCU Laboratory Worker Registration Form and training records
• Monitoring results
• Consultation records
• Reports and investigations of accidents in laboratories

VIII. Laboratory Safety Standards and Compliance
The health and safety of workers and building occupants is the most important factor to consider in laboratory work. In addition to these health and safety concerns, compliance with OSHA, and EPA regulations is also important because of the severe financial consequences, especially related to EPA hazardous waste regulations. Fines for seemingly minor violations, e.g., improper labeling, lids not screwed-on tight, etc., may run into the tens of thousands of dollars; therefore compliance with these regulations must receive special attention.

As required by state and federal law, EHS inspects and surveys all campus research groups at least annually. Surveys are comprehensive and using the Laboratory Audit Checklist to address record keeping, fire safety, egress, engineering controls, personal protective equipment, work practices, and where appropriate, chemical, and biological safety. Referral inspections are used to follow-up on issues noted during annual inspections or upon receiving reports of non-compliance or unsafe and unhealthy conditions.

When considering violations or safety issues in the laboratory, EHS must take into account the severity of the issue as it relates to personnel and property. All departures from laboratory standards and best practices are graded for risk using definitions in the table below during the annual audits.

### Violation Severity and Enforcement

<table>
<thead>
<tr>
<th>Violation and Severity</th>
<th>Enforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imminent danger</strong> - reasonable certainty a hazard exists that can be expected to cause serious physical harm</td>
<td>EHS notifies laboratory personnel to cease operations immediately and close the laboratory. EHS will work with PI and department head for immediate abatement or a plan for isolating the hazard. University Police may be used to secure the area if necessary. Lab will not reopen until EHS has performed follow-up inspection to ensure compliance and safety.</td>
</tr>
<tr>
<td><strong>Critical departure</strong> - will probably lead to physical harm or significant exposure to biological or physical agents or violates regulatory standards</td>
<td>EHS notifies laboratory personnel and PI of the violation and sets a deadline for abatement, and may recommend that the PI shut down the operation until abated. EHS will perform follow-up inspections to ensure compliance.</td>
</tr>
<tr>
<td><strong>Non-critical departure</strong> - direct relationship to health and safety but probably would not cause serious physical harm or significant exposure to hazardous agents</td>
<td>EHS notifies laboratory personnel and PI of the violation and requests abatement as soon as practicable.</td>
</tr>
<tr>
<td><strong>Documentation</strong> - required documentation has not been completed, updated, submitted, and/or retained</td>
<td>EHS notifies laboratory personnel and PI of the missing documentation and requests abatement as soon as practicable.</td>
</tr>
</tbody>
</table>
EHS sends the completed Laboratory Audit Checklist reports to the Principal Investigator within two weeks of the inspection (Figure 1). Principal Investigators are to correct all non-compliant issues or unsafe or unhealthy conditions identified during the inspections and a written response back to EHS is due within two weeks of receipt of the report. If a PI cannot adhere to that deadline, it is their responsibility to notify EHS prior to the deadline and arrange an alternate date.

If EHS does not receive a written response by the deadline, the laboratory will be non-compliant. EHS will notify the PI, Department Head, and Dean that the next day, laboratory access will be denied to all faculty, staff, and students pending a written response to the inspection report.

A. Laboratory Self-Audits

The people who work in laboratories know the equipment, processes and personnel better than anyone. At NCCU PIs are strongly encouraged to establish a schedule for regular self-inspections to complement and prepare for the annual inspection coordinated by EHS.

The Laboratory Audit Checklist is the same form used by EHS during the annual inspections. Contact EHS with any special concerns that arise from these self-audits, and repeat audits frequently in order to track whether your lab is making improvements.
Figure 1. Diagram of lab audit process.

B. Reporting Hazards

The Occupational Safety and Health Act of North Carolina makes provisions for employees to request an inspection or evaluation of conditions that they believe may constitute a health or safety hazard. University employees are encouraged to report such conditions to EHS and to request an investigation into the need for corrective action.

Employees who are aware of a health hazard or unsafe condition are encouraged to report using the **Eagle Health & Safety (EHS)** system:
Figure 2. Eagle Health & Safety (EHS) sticker designed to enable visibility and ease of reporting safety hazards in real time.

Persons reporting an issue may request confidentiality and every effort will be made to withhold their name from the public, their immediate supervisor, and department head.

After EHS has concluded its investigation, results are communicated, in writing, to the party requesting the investigation and other appropriate University personnel, with due consideration to anonymity requests. EHS will initiate corrective action if there are reasonable grounds to believe that a violation or danger exists. If EHS cannot implement corrective action within a reasonable period, EHS may terminate the operations pending corrective action.

IX. Laboratory Safety

The National Institute for Occupational Safety and Health (NIOSH) depicts the hierarchy of controls for safety measures as an inverted pyramid with the most effective types of control measure (elimination) at the top and the least effective (personal protective equipment) at the bottom.
Figure 3. National Institute of Occupational Health Hierarchy of Controls describes five levels of controls or actions you can take to reduce or remove hazards in the order of general effectiveness. Source: http://www.cdc.gov/niosh/topics/hierarchy

A. Elimination and Substitution

By its nature, laboratory work is considered hazardous as it exposes laboratorians to risks not generally encountered outside of the laboratory environment. Elimination and substitution are considered the most effective control measures. They are easiest to achieve for brand new processes but are more difficult to implement for existing processes.

Complete elimination of hazards would often defeat the purpose of the research being done inside of a laboratory. Laboratorians should work to eliminate chemicals, materials, processes, and equipment that are unnecessary to specific experiments. Can you reduce the amount of chemical and still achieve the desired result? Can you substitute one biological hazard for a lesser hazard (i.e. is there a BSL-1 agent that could substitute in early experiments for a BSL-2 agent)? Switch out processes, equipment, material, or other components where possible.

B. Engineering Controls

Engineering controls are designed to physically separate the laboratorian from the hazard. Although elimination and substitution are separate controls in the hierarchy of control measures, they are also considered engineering controls because they are designed to remove the hazardous source before the worker makes contact.
C. Laboratory Engineering Controls

<table>
<thead>
<tr>
<th>Mechanism of Control</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
</table>
| Isolate              | Reduce or remove hazards by separation in time or space. | • Restrict access to lab during some experiments  
                     |             | • Schedule time for high-risk experiments |
| Enclose              | Put hazards or processes into a closed system | • Sealed centrifuge cups/rotors |
| Shield               | Separate people from chemical, biological or physical hazards | • Biosafety cabinet  
                     |             | • Fume Hood |

D. Administrative Controls

While engineering controls seek to physically separate laboratorians from hazards, administrative controls aim to minimize a lab worker's exposure. Administrative controls are the existing safety rules and protocols put in place for workers in the lab to follow. Following are examples of administrative controls:

- Standard Operating Procedures and checklists
- Training
- Mandating that no one should work in the lab alone

E. Personal Protective Equipment (PPE)

Even though the hierarchy of control measures indicates PPE is the least effective of control measure, it's utility in providing protection should not be underestimated. The success of PPE depends in part on whether or not laboratorians comply and utilize it correctly.

Goggles, hearing protection, and protective clothing (e.g., lab coats and gloves) are the most recognizable and most used PPE in the lab. PPE is always essential, and especially critical when:

- engineering controls are not feasible or they do not totally eliminate a hazard;
- engineering controls are being developed; and
- in an emergency situation.
X. Engineering Controls

A. Biosafety Cabinets

Biological safety cabinets (BSC) are a type of engineering control designed to prevent exposure of laboratory personnel and contamination of the room environment from hazardous biological aerosols. BSCs can also provide a clean work environment to protect cell cultures or sterile materials (product).

There are three classes of BSCs, designated as Class I, Class II, and Class III. Class I and II cabinets provide a protective air barrier that separates the laboratorian from the work area. Class II cabinets also provide a HEPA-filtered laminar flow to the work surface to protect the sterility of products from contamination in the room. An excellent description and comparison of all types of BSCs can be found in Appendix A of the CDC Biosafety in Microbiological and Biomedical Laboratories publication.

BSCs are designed to provide containment of hazardous aerosols by three mechanisms: air barrier, physical separation, and high-efficiency particulate air (HEPA) filtration.

1. Air Barrier

Containment is provided by directional movement of room air from the laboratory, past the laboratorian, and into the BSC via the work opening. Hazardous aerosols generated during experimental procedures are captured by this flow of air and directed through the BSCs HEPA filters.

Some BSCs provide protection for experimental procedures by providing uniform, unidirectional HEPA filtered air, referred to as laminar airflow, continuously flowing over the work area. Laminar airflow minimizes turbulence inside the cabinet, allowing for immediate removal of contaminants generated by the procedures. Disruption of the airflow patterns in the cabinet can compromise the integrity of the containment provided by air barriers, and objects within the cabinet can disrupt airflow patterns.

2. Physical Separation

Physical barriers between the hazard and the laboratorian and laboratory are impervious surfaces such as the metal walls, glass sash and exhaust duct work.

3. HEPA Filtration

HEPA filters have a minimum particle collective of 99.97% for particles of 0.3 μm diameter or more. Because of their high efficiency, HEPA filters in biological safety cabinets can remove virtually all particulates, including hazardous microbiological and some chemical aerosols, in the air stream passing through the filter. HEPA filters are not effective in capturing chemical vapors, and are not considered protective against gases or vapor-phase
solids/liquids.

BSCs that are designed to protect product as well as personnel will also have a supply HEPA filter which filters the air that is provided in a laminar flow over the work surface.

**Figure 4.** Class II, Type A2 BSC. (A) front opening, (B) sash, (C) exhaust HEPA filter, (D) supply HEPA filter, (E) common plenum, (F) exhaust blower. Diagram source BMBL 6th Edition.

BSCs are only designed to supplement good microbiological technique – not replace it. If users do not properly understand how to operate and work safety within a BSC, they will not maintain an adequate protective barrier between themselves and the hazard. Details on proper use of a BSC are found in the NCCU Biological Safety Manual.

A BSC certifier tests and evaluates the performance of each BSC after initial installation, whenever moved, after HEPA filters are changed, and at least annually thereafter. BSCs that do not have a current certification should be taken out of service, proper signage placed to prohibit use, and remain completely empty of all materials until
certified. Never work in a BSC that is not currently certified.

B. Laminar Flow Clean Bench

Horizontal and vertical laminar flow clean benches are sometimes mistaken for biological safety cabinets. **Clean benches provide product protection but no personnel protection.** The horizontal flow clean bench discharges HEPA filtered air across the work surface onto the operator. The less common vertical flow clean bench discharges air downward from a HEPA filter above the work surface. The airflow leaves the work area through the front opening where the operator is located. With both versions of the clean bench, work performed on the work surface could expose the operator to contaminants.

Researchers often use clean benches for assembly of sterile apparatus. Do not use clean benches for handling cell cultures, drug formulations, biological hazards, or chemicals.

C. Chemical Fume Hood

A fume hood is designed to minimize exposure to hazardous chemical vapors by drawing harmful vapors away so laboratorians can work safely with chemicals. The air is extracted from the fume hood and filtered to remove dangerous vapors, and then either exhausted outside of the building or recirculated back into the lab. The fume hood works by using a sash (a window that opens or closes to protect the user) to contain the vapor and keep it away from the user’s face or to prevent it from drifting out into the rest of the laboratory. Blowers draw in air from the room, through a filter within the fume hood and towards an exhaust area.

The airflow will differ depending on the type of hood you use. For a constant air volume (CAV) hood, the fan has only one speed, providing a stable and continuous airflow. A variable air volume (VAV) hood allows users to adjust the velocity of the exhaust for added versatility, while reduced air volume (RAV) hoods offer lower airflow performance, making them ideal for working with less harmful compounds.

To work safely in a fume hood:

- Reduce obstructions to allow adequate air flow across the working surface with minimum turbulence.
- Minimize the number of objects in the hood – keep at least 50% of the working surface clear, if possible.
- Place containers and equipment toward the sides of the hood
- If possible, elevate equipment and containers two to three inches above the working surface using perforated or slotted shelving
- Always work with chemicals at least six inches into the hood from the face.
• Check the airflow indicator prior to use to ensure the fume hood is drawing air. If an airflow monitor is not installed, test the hood airflow with a piece of tissue or Chemwipe at the sash.
• Keep the sash at 18 inches or less from the working surface while working in the hood.
• EHS provides these stickers to remind users of the proper sash height

![SASH HEIGHT 18”]

• Keep laboratory doors and windows closed and limit movement in front of the hood.
• If your hood is not working properly, do not use until the problem has been fixed. Place signage on the hood indicating it is out of service.
• Never place your head inside the fume hood when working with chemicals.

D. Glove boxes

Unlike a chemical hood, gloveboxes are fully enclosed and are under negative or positive pressure. Gloveboxes have multiple openings in which arm-length rubber gloves are mounted. The operator works inside the box by using these gloves.

A glovebox operating under negative pressure is generally used for highly toxic materials, when a chemical hood might not offer adequate protection. A glovebox operating under positive pressure may be used for experiments that require protection from moisture or oxygen or a high-purity inert atmosphere. Nanoparticles can also be used in a glovebox.

The airflow through the glovebox is relatively low, and the exhaust usually must be filtered or scrubbed before it is released into the exhaust system. To ensure adequate protection to laboratory personnel, these devices must be routinely leak tested to ensure that enclosure integrity is sufficient. Because leak testing requires specialty equipment it is not considered part of the NCCU contract for fume hood and biological safety cabinet annual certification. Leak testing is the responsibility of the equipment owner but will be verified as completed as part of the annual laboratory inspection.

E. Snorkels

Snorkels consist of a bell mouth and an articulated connection to the exhaust system and do not fully surround the reaction at the point of release. Snorkels are not a substitute for a fume hood when handling toxic chemicals. Snorkels are far less effective in capturing dusts, mists, or fumes, and can typically only capture contaminants released within 6 inches of the unit. Snorkels are extremely susceptible to cross drafts and a number of factors can adversely affect a snorkel’s ability to properly capture emissions:
• Improper positioning of the inlet funnel.
• Lab equipment placed too close to room exhaust
• Sudden changes in room pressure, such as an entry door or hood sash being opened
• A person walking or moving too fast in the vicinity

A good use for laboratory snorkels is the capture and removal of thermal updrafts from benchtop-heated processes, or as local ventilation for benchtop apparatuses such as gas chromatographs.

F. Testing and Certification

Biosafety cabinets, fume hoods and other air handling equipment requires annual testing and certification mandated by many agencies including:
• Occupational Safety and Health Administration (OSHA)
• American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
• American National Standards Institute (ANSI)
• American Society of Safety Engineers (ASSE)
• National Fire Protection Association (NFPA)

This equipment must be inspected and certified after initial installation, whenever moved, and at least annually thereafter. The annual lab inspection team will review these records. Equipment that does not have a current certification should be taken out of service, proper signage placed to prohibit use, and remain completely empty of all materials until certified.

G. Repairs and Maintenance

EHS provides signage to laboratories for placement on BSCs and fume hoods to provide users with pre-use checks and instructions for who to call and what to do in the event that equipment is not functioning properly (Figure 5). An out service sign is included in this signage.
Check before working in this chemical fume hood:
- Are doors to room closed?
- Was hood certified within past 12 months?
- Is face velocity 70-150 fpm?
- Is sash 18” from airflow? (should be marked on frame)
- Are there openings in interior walls? (missing valves, panels, etc.)
- Is 50% of work surface is clear?
- Is sash glass is fully intact?
- Is the hood in alarm?
- If hood is not fully operational or compliant, do not use
- Place out of service signage on hood and notify responsible person
- Submit a repair request to EHS at https://bit.ly/35O4A9t, or by scanning QR code

Check before working in this biological safety cabinet (BSC):
- Is certification date within past 12 months?
- Is sash correctly positioned and not in alarm?
- Have you disinfected work surface and cleared out unnecessary materials?
- Is sash glass is fully intact?
- Does magnetic reading match current certification sticker?
- Is all lighting on and functional?
- If BSC is not fully operational or compliant do not use
- Place out of service signage on BSC and notify responsible person
- Submit a repair request to EHS at https://bit.ly/35O4A9t, or by scanning QR code

![EHS sign for fume hood and biosafety cabinet]

**Figure 5.** EHS signs provided to labs for fume hoods and biosafety cabinets.
XI. Administrative Controls

A. Eating, Drinking, and Smoking

Contamination of food, drink, tobacco products, and cosmetics is a potential route for ingestion of a hazardous substance. University policy prohibits smoking inside or within 25 feet of any University building. Store, handle, and consume food and drink items in areas free of hazardous substances. Designate non-laboratory areas, such as break rooms, lounges or conference rooms, as food storage and eating areas for laboratory personnel.

1) Wash food containers, dishes, and utensils only in sinks exclusively designated for food utensils. Wash laboratory glassware or equipment in separate sinks. Do not use glassware or utensils used for laboratory operations for food or beverages.

2) Do not use laboratory refrigerators, ice chests, and cold rooms for food storage. All lab cold storage should be posted with proper signage.

3) Designated food item areas must be free from all research-related items, including personal protective equipment (e.g. lab coats, gloves, safety glasses).

B. Housekeeping

Safety and orderliness in the laboratory are related. When housekeeping standards fall, safety performance inevitably deteriorates. Keep work areas clean, and properly label and store chemicals and equipment.

- Cleanup should follow the completion of any operation or at the end of each day
- Deposit wastes in appropriately labeled receptacles, and clearly mark temporary holding containers.
- Do not accumulate unneeded chemicals.
- Stairways and hallways cannot be storage areas. Maintain free, unobstructed access to exits and emergency equipment, such as eyewash stations and emergency showers.
C. Fire Code Clearance

North Carolina Building Code and National Fire Protection Association (NFPA) standards require an 18-inch minimum clearance between the sprinkler head and the top of storage. The 18-inch requirement is not intended to limit the height of permanent shelving on a wall, if the shelving is incorporated into the building design and not directly below the sprinklers. Such shelving may extend above the 18-inch plane below the sprinkler. Shelving added to the building post-construction and any storage on the shelves may not extend above the plane 18 inches below the sprinkler head. In rooms without sprinklers, no items may be stored within 24” of the ceiling.

In labs that contain electrical panel boxes, working space totaling 30 inches or the width of the equipment, whichever is greater must be left open to allow unimpeded access to the panel at all times. In an electrical emergency it is imperative that personnel are able to reach this equipment to shut down electrical power if necessary.

D. Working Alone

Avoid performing experiments alone in a laboratory building. Arrange with individuals working in separate laboratories inside the same building outside of working hours to cross check periodically. Do not undertake experiments known to be hazardous when alone in a laboratory.

The Principal Investigator is responsible for determining whether the work requires special safety precautions, such as having two persons in the same room during a particular operation.

E. Hazard Communication Signage

As required by regulation and for the benefit of NCCU personnel, contractors, first responders, or other visitors a Hazard Communication Sign must be present on all research and teaching laboratory doors and any other spaces where hazardous materials may be present. This sign is not intended to prohibit access, but to communicate hazards present in the laboratory for awareness.

EHS provides a door sign template for research labs and teaching labs to be used for research and teaching laboratory doors on the EHS website (Figure 5). Signage will be inspected as part of annual laboratory inspections.

Through symbols, icons, and text the types of hazards (e.g. biological, chemical) potentially present in the lab are communicated to all. The sign will also list PI(s) and emergency contact information.

The potential hazards in the space may provide direction on personal protective equipment (PPE) or other safety precautions that are required for entry.
1. Biohazards

The CDC/NIH Biosafety in the Microbiology and Biomedical Laboratory, 6th edition (BMBL) calls for a biohazard sign to be posted at the laboratory entry where biohazardous materials are present.

2. Chemical Hazards

Signage will incorporate the National Fire Protection Association (NFPA) 704 fire diamond to communicate the hazard of short-term, acute exposures to chemicals that could occur as a result of a fire, spill or similar emergency. See the Chemical Safety Plan for full description of NFPA labeling.

3. Lasers

The laser symbol is incorporated when Class 3B or Class 4 lasers are present in the laboratory. Do not enter unless accompanied by lab personnel. When the laser is in operation, individuals entering this room must wear approved laser protective eyewear provided by lab personnel, if required by lab operating procedures for safe entry.

4. Compressed Gas Hazard

Laboratories with compressed gas cylinders must include the compressed gas hazard symbol on their laboratory signage.

5. Magnets

The magnet symbol indicates the presence of a magnetic field. It is critical that access to magnets and equipment that generates magnetic fields be restricted by locked doors posted with magnetic hazard warning signs to prevent unauthorized access.
Figure 6. Research laboratory door signage (top) and teaching laboratory door signage (bottom) templates to be customized for each entry point when hazards are present.
E. Transport of Hazardous Materials

Hazardous materials require specific packaging and labeling according to their potential hazards. Biological materials must be prepared and shipped according to Department of Transportation (DOT) and International Air Transport Association (IATA) regulations. These regulations state that you must receive specific training to legally package, ship or transport a hazardous biological material – including biological waste. Contact EHS to receive this training and to identify the specific requirements for your materials.

It is critical to remember that Fayetteville Street is a public roadway and transport of hazardous biological or chemical (including dry ice) by vehicle is subject to all DOT regulations for training, placarding, insurance, and liability. **You should never hazardous items by vehicle unless you meet all DOT and NCCU requirements and been expressly cleared to do so by EHS.**

Transporting potentially hazardous materials outside of the laboratory requires a durable leak-proof secondary container. Containers should be gasketed, labeled, and closable. Use secondary containers (e.g. Ziploc bag with a paper towel or other absorbent material) if the primary container may become contaminated or punctured. Label the outermost container with the appropriate hazard symbol.

F. Support Personnel

Laboratory research may also expose maintenance, environmental services, and other support personnel to potential physical and chemical hazards in the laboratories. You can keep their exposure risk to a minimum through the use of proper signage, labeling, and good laboratory housekeeping practices.

G. Laboratory Equipment

The very nature of research requires specialized equipment for laboratories. Because specialized research equipment is often not formally tested and validated to meet American safety standards (e.g., U.L. Listed), and procurement and installation may require unplanned infrastructure improvements including, but not limited to electrical service, HVAC capacity, noise/vibration dampening and structural loading, specialized equipment for laboratory use must be reviewed and approved prior to purchasing equipment.

To ensure that equipment is purchased and installed in a safe manner and all parties are aware of the purchase to ensure compliance with maintenance, safety protocols, training, and required inspections a Laboratory Equipment & Instrumentation Pre-Purchase Checklist must be completed and submitted online prior to placing an order for laboratory equipment.
XII. Personal Protective Equipment and Clothing

Personal protective equipment (PPE) is an important way to minimize exposure by preventing absorption, inhalation, and physical contact. PPE includes gloves, safety glasses, and lab coats. Proper selection and use of PPE is critical to protection. The PI is responsible for providing all laboratory personnel with appropriate PPE, which should be designed for the task and should fit the employee well.

A. Eye and Face Protection

Students, faculty, staff, and visitors in laboratories must wear eye protective devices while in the laboratory space (regardless of anticipated eye hazards) with the exception of within desk areas where no hazards are present. The type of safety device required is determined by risk assessment based on the nature of the hazard and the frequency with which the wearer encounters it. PIs must determine the appropriate level of eye protection for particular tasks, and enforce eye protection rules.

OSHA requires that the employer provide eye and face protection devices without cost to students, employees and visitors. Each department is responsible for funding its eye and face protection program. If prescription safety glasses are necessary, the employee and/or student are responsible for scheduling and payment for eye examinations to obtain a current prescription. Prescription safety glasses are available for State Employees at a discounted rate from Correction Enterprises.

Contact lenses do not provide adequate eye protection for hazardous operations and must be worn in conjunction with approved safety eyewear. The University permits the wearing of contact lenses in laboratories, only if the wearer includes an approved method eye protection. Earlier guidance recommended against wearing of contact lenses in laboratories, due to concerns about lenses trapping chemicals. However, several years of subsequent studies have shown that contact lenses do not create an additional hazard; in fact, the improved visual acuity from contact lenses might help prevent accidents, compared to no corrective lenses.

Eye protective devices issued to employees, students and visitors remain the property of the University. Persons issued eye protective devices return it when the use of the device is no longer necessary. The department shall determine the disposition of prescription glasses. You may replace eye protective devices damaged during normal wear and use without charge at the discretion of the PI. Replacement of lost or stolen devices is the responsibility of the employee or student issued the equipment.

Eye protective devices are personal items, issued for the exclusive use of each individual. Clean with soap and water and store in a clean, protected area. Thoroughly clean and disinfect all eye protective devices before issuing to another person.
There are three basic types of eye and face protection that meet the basic eye protection standards for frontal exposure to flying particles: safety glasses with side shields, goggles, and face shields.

1. Safety Glasses

Safety glasses must be hardened-glass or plastic safety spectacles with side shields that comply with the Standard for Occupational and Educational Eye and Face Protection (Z87.1) established by the American National Standards Institute (ANSI). This standard specifies a minimum lens thickness of 3 mm, impact resistance requirements, passage of a flammability test, and lens-retaining frames.

Ordinary prescription glasses do not provide adequate protection from injury to the eyes. Prescription safety spectacles are recommended for employees wearing glasses. Do not wear photogrey (transition) lenses indoors in laboratory environments, because the percentage of light transmitted under normal light conditions is below ANSI standards.

2. Goggles

Goggles provide a tighter face seal than safety glasses, and are not for general laboratory use. Wear them when there is a hazard from splashing chemicals or flying particles. For example, wear goggles when using glassware under reduced or elevated pressure, or using glass apparatus in combustion or other high temperature operations.

Impact-protection goggles have perforated sides to provide ventilation and reduce fogging of the lens, but do not offer full protection against chemical splashes. Use chemical goggles with splash-proof sides for protection from harmful chemical splash.

There are also specific goggles and masks for glassblowing and intense light sources such as welding or lasers. For questions about laser safety, contact EHS.

3. Face shields

Goggles or safety glasses alone do not meet ANSI standards for protection to the face and neck. When you need greater protection from flying particles and harmful liquids, wear full-face shields that protect the face and throat.

Consider using a face shield or mask when operating a vacuum system (which may implode), or conducting a
reaction with the potential for mild explosions. Always use a UV-blocking face shield and other skin-covering PPE when working with transilluminators or other devices that produce ultraviolet radiation.

B. Gloves

Wear proper protective gloves for potential contact with hazardous materials, sharps, and hot or cold materials. Select gloves based on the material handled, the particular hazard involved, and their suitability for the operation conducted. It is the responsibility of the PI to provide the proper gloves for each task in the lab and to enforce the lab glove policy including glove types and proper disposal. OSHA has guidance on glove selection and chemical resistance.

While it is important to wear gloves to protect the hands against potentially hazardous materials, it is equally important to remove gloves before contacting “clean” areas such as food area surfaces, or common equipment such as telephones, computer keyboards, and photocopiers.

General glove considerations:

- Consider double gloving when handling highly toxic or carcinogenic materials
- Before each use, inspect gloves for discoloration, punctures, and tears
- Dispose single-use gloves after you remove them – never reuse single-use disposable gloves
- Always store gloves properly (e.g. away from windows, transilluminators, etc.), since some glove materials are susceptible to ultraviolet damage.
- Never wear gloves outside of the laboratory – remove gloves and wash hands before exiting the lab
- Use secondary containment for items transported outside of the lab that should not be handled with bare hands
- Remove gloves even if you believe they are non-contaminated, as others do not know if you might have handled hazardous materials with your gloved hand(s)
- You can dispose gloves in the regular trash if they are not contaminated with biohazards, chemicals, nanoparticles, etc. For gloves contaminated with these substances, dispose in the proper waste stream. Do not dispose of contaminated gloves in a manner that could expose other personnel
- All disposable gloves have an expiration date on the box. Do not use gloves past the expiration date.
### Personal Protective Equipment Guidance for NCCU Laboratories

<table>
<thead>
<tr>
<th>Task/Activity Involves</th>
<th>Use the Following PPE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chemicals</strong></td>
<td></td>
</tr>
<tr>
<td>Solids of low or moderate toxicity</td>
<td>• Nitrile or other appropriate gloves</td>
</tr>
<tr>
<td>Small volumes (&lt;4 L of corrosive or flammable liquids, organic solvents)</td>
<td>• Safety glasses or goggles</td>
</tr>
<tr>
<td></td>
<td>• Appropriate chemical-resistant gloves</td>
</tr>
<tr>
<td></td>
<td>• Lab coat – minimum 65% polyester</td>
</tr>
<tr>
<td>Large volumes (&gt;4 L) of corrosive or flammable liquids, organic solvents, work which creates splash hazard</td>
<td>• Safety goggles</td>
</tr>
<tr>
<td></td>
<td>• Appropriate chemical-resistant gloves</td>
</tr>
<tr>
<td></td>
<td>• Acid-resistant apron for highly corrosive chemicals</td>
</tr>
<tr>
<td></td>
<td>• Lab coat with flame and/or splash resistance</td>
</tr>
<tr>
<td>Potentially-explosive compounds</td>
<td>• Face shield</td>
</tr>
<tr>
<td></td>
<td>• Appropriate chemical-resistant gloves</td>
</tr>
<tr>
<td></td>
<td>• Nomex or Shieldtec flame/splash resistant lab coat</td>
</tr>
<tr>
<td>Pyrophoric (air-reactive) solids or liquids</td>
<td>• Face shield</td>
</tr>
<tr>
<td></td>
<td>• Appropriate chemical-resistant gloves</td>
</tr>
<tr>
<td></td>
<td>• Nomex/Shieldtec flame/splash resistant lab coat</td>
</tr>
<tr>
<td>Particularly hazardous substances including carcinogens, reproductive toxins, and reagents of high acute toxicity</td>
<td>• Safety glasses or goggles</td>
</tr>
<tr>
<td></td>
<td>• Appropriate chemical-resistant gloves</td>
</tr>
<tr>
<td></td>
<td>• 80/20 poly/cotton blend lab coat</td>
</tr>
<tr>
<td></td>
<td>• Respiratory protection may be needed</td>
</tr>
<tr>
<td>BSL1-BS2 pathogens, viral vectors, human materials or non-human primate materials</td>
<td>• Nitrile or other appropriate gloves</td>
</tr>
<tr>
<td>Procedures outside of BSC when splashes or sprays are likely</td>
<td>• Lab coat</td>
</tr>
<tr>
<td></td>
<td>• Eye protection</td>
</tr>
<tr>
<td>Handling hot surfaces and objects</td>
<td>• Heat-resistant gloves</td>
</tr>
<tr>
<td></td>
<td>• Rubber apron</td>
</tr>
<tr>
<td>Glassware under pressure or vacuum</td>
<td>• Face shield recommended</td>
</tr>
<tr>
<td></td>
<td>• Lab coat</td>
</tr>
<tr>
<td>Cryogenic liquids</td>
<td>• Face shield</td>
</tr>
<tr>
<td></td>
<td>• Insulated gloves</td>
</tr>
<tr>
<td>Using sharps for infected animal necropsy or surgery, cutting tubing, etc.</td>
<td>• Safety glasses or goggles</td>
</tr>
<tr>
<td></td>
<td>• Cut-resistant gloves</td>
</tr>
<tr>
<td>Sonicator or other loud equipment</td>
<td>• Hearing protection</td>
</tr>
</tbody>
</table>

**Biologicals**

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</thead>
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<td>Glassware under pressure or vacuum</td>
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<tr>
<td></td>
<td>• Lab coat</td>
</tr>
<tr>
<td>Cryogenic liquids</td>
<td>• Face shield</td>
</tr>
<tr>
<td></td>
<td>• Insulated gloves</td>
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<td>Using sharps for infected animal necropsy or surgery, cutting tubing, etc.</td>
<td>• Safety glasses or goggles</td>
</tr>
<tr>
<td></td>
<td>• Cut-resistant gloves</td>
</tr>
<tr>
<td>Sonicator or other loud equipment</td>
<td>• Hearing protection</td>
</tr>
</tbody>
</table>
1. Latex

One of the most common chemicals that laboratory workers are exposed to is latex. Exposure most often occurs through direct contact with latex, a natural plant derivative used in making certain disposable gloves and other products. Sensitivity type reactions may occur and may range from localized dermatitis (skin irritation) to immediate, possibly life-threatening reactions.

Under OSHA's Personal Protective Equipment standard, 29 CFR 1910.132, the employer must ensure that appropriate personal protective equipment (PPE) is accessible at the worksite or issued to workers. Latex-free gloves must be readily accessible to those workers who are allergic to latex gloves or other latex-containing PPE, 29 CFR 1910.1030(c)(3)(iii).

Latex allergy should be suspected in workers who develop certain symptoms after latex exposure, including:

- nasal, eye, or sinus irritation
- hives or rash
- difficulty breathing
- coughing
- wheezing
- nausea
- vomiting
- diarrhea

An exposed worker who exhibits these symptoms should report to their Supervisor and contact EHS to arrange for a medical evaluation.

C. Respirators

Respiratory protection might be necessary when working with highly toxic chemicals, biological hazards, or dusts known to cause asthma or pulmonary fibrosis. However, respirators are a “last line” of defense, and should not be used until all engineering controls (e.g. ventilation) and work practice controls (e.g. product substitution) are exhausted.

NCCU has developed a Respiratory Protection Plan and Respiratory Protection Training in compliance with 29 CFR 1910.134 which details all requirements and training for wearing respirators at NCCU.
D. Clothing and Protective Apparel

The clothing you wear in the laboratory can affect your safety. Do not wear loose or torn clothing and avoid clothing which does not provide adequate protection by exposing skin (e.g., shorts, halter-tops) in the laboratory. Unrestrained long hair can easily catch fire, dip into chemicals, or become ensnared in apparatus and moving machinery.

Laboratory coats help prevent contact with dirt and the minor chemical splashes or spills encountered in laboratory-scale work. The cloth laboratory coat is, however, primarily a protection for clothing and may itself present a hazard (e.g., combustibility) to the wearer. Laboratory coats do not significantly resist penetration by organic liquids. Remove your lab coat immediately upon significant contamination.

The preference is for knitted or gathered sleeves to reduce wrist exposure and sample contamination. Further, snap closures are preferred to buttons or zippers to allow for quick removal of the lab coat in the event of a spill or splash. Lab coats should be worn with sleeves fully extended and fully snapped to provide as much coverage as possible.

Do not take lab coats home and launder them because of the potential for contamination of the home environment. NCCU utilizes a vendor to launder and return all laboratory coats.

Plastic or rubber aprons provide better protection from corrosive or irritating liquids but can complicate injuries in the event of fire. Furthermore, plastic aprons accumulate a considerable charge of static electricity, so avoid use in areas with flammable solvents or other materials ignitable by static discharge.

In some cases, disposable outer garments (e.g., Tyvek®) are preferable to reusable ones. One example is handling appreciable quantities of known carcinogenic materials, for which EHS also recommends long sleeves and gloves. Wear disposable full-length jump suits for high-risk exposure situations, which may also require the use of head and shoe covers. Many disposable garments, however, offer only limited protection from vapor penetration and you need to exercise considerable judgment when using them.

Know the appropriate techniques for removing protective apparel if contaminated. Chemical spills on leather clothing accessories (watchbands, shoes, belts, etc.) are especially hazardous, since many chemicals absorb in the leather, which holds the chemical close to the skin for long periods. Remove such items promptly to prevent or minimize chemical burns. If possible, decontaminate these items and if that is not possible discard as hazardous waste.

E. Foot Protection

Wear sturdy, closed-toed shoes at all times in laboratories or other chemical use and storage areas. Do not wear
perforated shoes or sandals in laboratories. In some chemical laboratories, shoes made of cloth may be prohibited to protect against chemical spills and splashes.

XIII. Accidents, Incidents, Near Misses, and Emergencies

**Incidents** are events that have the potential to cause injury or damage but do not necessarily result in any harm.

**Accidents** are events that cause injury or damage. They often occur suddenly and without warning.

**Near misses** are incidents that nearly caused injury or damage but didn’t due to timely intervention or luck.

In the laboratory, **ALL** incidents, accidents, and near misses must be reported. The following table shows the reporting requirements for various types of incidents.

<table>
<thead>
<tr>
<th>Incident Type</th>
<th>Reporting Timeline</th>
<th>Reporting Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any accident requiring emergency medical response</td>
<td>Immediately</td>
<td>911 or University Police x6106</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Principal Investigator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environmental Health &amp; Safety</td>
</tr>
<tr>
<td>Non-emergency medical Exposure/Potential Exposure</td>
<td>Immediately</td>
<td>Principal Investigator</td>
</tr>
<tr>
<td>Needle stick with contaminated sharp</td>
<td></td>
<td>Environmental Health &amp; Safety</td>
</tr>
<tr>
<td>Chemical exposure</td>
<td></td>
<td>Workers’ Compensation Administrator (employee)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Student Health (student)</td>
</tr>
<tr>
<td>Use of any safety equipment:</td>
<td>Immediately</td>
<td>Principal Investigator</td>
</tr>
<tr>
<td>emergency eyewash or shower, fire</td>
<td></td>
<td>Environmental Health &amp; Safety</td>
</tr>
<tr>
<td>extinguisher, spill kits, first aid kits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Property damage or disruption of facility</td>
<td>When discovered</td>
<td>Facilities Operations for response</td>
</tr>
<tr>
<td>operations (fire, flood, etc.)</td>
<td></td>
<td>Principal Investigator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environmental Health &amp; Safety</td>
</tr>
<tr>
<td></td>
<td></td>
<td>University Police (after hours only)</td>
</tr>
<tr>
<td>Large hazardous chemical spill</td>
<td>Immediately</td>
<td>Environmental Health &amp; Safety</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidents which disrupt the normal work process</td>
<td>Within 24 hours</td>
<td>Principal Investigator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environmental Health &amp; Safety</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(if safety related)</td>
</tr>
<tr>
<td>Concerns about co-worker mental health or fitness</td>
<td>Immediately</td>
<td>Principal Investigator</td>
</tr>
<tr>
<td>for duty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any unsafe conditions or hazards</td>
<td>Immediately</td>
<td>Principal Investigator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environmental Health &amp; Safety</td>
</tr>
</tbody>
</table>
A. Emergency Planning

It is the responsibility of each laboratory unit to establish emergency plans in the events of fire, chemical spills or other emergencies resulting from accidents within their laboratories. You also need to be familiar with the emergency plans and evacuation routes for your building.

In the event of a incident that requires first responders such as fire, major releases of hazardous chemicals to the environment, or life threatening injuries, call 911 immediately.

Communication between the laboratory, building, EHS and other response personnel is very important. The Principal Investigator and other laboratory personnel who know the hazardous materials involved and/or the particular circumstances of the accident must be present at the incident command site. Safety data sheets for all chemicals involved should be made available to first responders.

B. Fire

How you react in the event of fire depends on how well you have prepared for a fire emergency. Therefore, departments should ensure that all employees are familiar with the procedure to follow in the event of an emergency. In the event of an alarm, remember RACE.

- **R:** Remove anyone from immediate danger
- **A:** Activate the building fire alarm system and call 911.
- **C:** Confine the fire by closing all windows and doors.
- **E:** Evacuate and leave the building.

How to respond to a building fire:

1) Use a fire extinguisher if the fire is very small and you know how to use it safely
2) Crawl, if there is smoke
3) Feel doors before opening
4) Go to the nearest exit
5) Always use an exit stair, not an elevator
6) Close doors behind you
7) If you are on fire – Stop, Drop and Roll

If you get trapped inside:

1) Close the door
Laboratory Safety Manual
Version #2.0

2) Seal cracks
3) Open the windows if safe
4) Signal for help and phone 911
5) Do not jump
6) Wait for the fire department to reach you

Look for “areas of refuge” like stair enclosures or other side of corridor fire doors. Elevators are not safe during fires. Sometimes it may be safer to stay in a room. If there is an immediate threat to safety, ask others near you for assistance. If no help is available, seek refuge in a room with a window or stairway. If possible, call 911 to report your location and receive instructions from the Emergency Operator.

If you are disabled (even temporarily), you should always make pre-arrangements with the Building Supervisor for evacuation procedures in the event of an emergency. EHS can assist with these measures.

C. Emergency Response to Chemical Spills

Many laboratory spills are of limited hazard potential, and laboratory personnel can clean up safely. Your laboratory should be equipped to handle small, low-hazard spills. Please review the Chemical Safety Plan and Hazard Communication Plan for emergency response information to chemical spills.

XIV. Occupational Health Considerations

A. Immune Status

Hazard mitigations described in this biosafety plan are based on risks to healthy adults. Immune compromise or immunosuppression is a condition in which the immune system does not function as it does in non-compromised persons. Immune compromised laboratorians may be at increased risk of illness and/or more serious side effects of illness either through directly handling infectious materials or by working in the same laboratory space where infectious agents are manipulated.

There are many medical conditions that cause immune compromise. In general, if you have a medical condition that causes problems with your immune system, your primary physician will have informed you. Examples include but are not limited to:

- Infection with Human Immunodeficiency Virus (HIV)
- Prolonged use of corticosteroid medications by mouth or by injection
- Monoclonal antibody therapy
- Medications used by people who have received organ transplants
• Long term diabetes mellitus, kidney or liver disease
• Diseases that affect the bone marrow or white blood cells
• Certain forms of cancer
• Cancer chemotherapy and radiation therapy
• Chronic malnutrition
• Pregnancy (certain pathogens and chemicals)
• Spleen removal

NCCU encourages immunosuppressed individuals to consult with their health care provider who can work with the employee to determine if medical recommendations or restrictions are necessary to minimize exposure risk.Students can contact Student Health for a risk consultation.

B. Illness in the Laboratory

Laboratorians should notify their PI or lab manager of any conditions or concerns they have about health issues that may impact their safety in the laboratory. Acute health concerns such as fever, dizziness, lethargy, vertigo, nausea, etc. may put the individual at higher risk for a spill, accident or medical emergency when handling hazardous materials.

C. Types of Exposures

**Exposure events:** needle sticks or cuts with contaminated material, splash to unprotected face, direct contact of contaminated materials with mucous membranes (i.e. touch eye, nose, mouth with contaminated hands), direct contact of contaminated materials with broken skin, or an aerosol generating event involving a human pathogen outside of BSC.

**Potential exposure events:** failure of personal protective equipment with no known aerosol or direct contact with infectious materials, spills, needle stick or cut with object not known to be contaminated. Loss of primary containment with spill constitutes a potential exposure.

Employees and students experiencing any of the symptoms associated with exposure to an agent that they have been in contact with must report to their PI and EHS even if there was no known exposure event. If the known or potential exposure occurs outside of normal work hours, laboratorians should contact their PI by telephone immediately.

D. Getting Treatment for Laboratory Injuries or Illness

Injured laboratorians should receive prompt treatment of injuries and evaluation of exposures—obtaining necessary medical attention is *always* the first priority.

1) Call 911 or campus police at 919-530-6106 if the situation requires more than basic first aid
2) Never transport injured persons in a personal vehicle
   a. NCCU has no liability in a personal vehicle if person’s condition worsened or the vehicle were involved in an accident
3) Injured persons are discouraged from self-transport
4) During normal business hours send non-emergencies to Student Health Services for triage during business hours
5) Contact Workers’ Compensation Administrator Cathy Allsbrook to determine where employees should seek non-emergency treatment during business hours

E. Reporting Injury or Illness

All accidents/injuries/exposures are reported using the [Eagle Safety Hazard system](#) or by calling 919-530-7125. Following injury/accident/exposure EMPLOYEES must:

- Report the incident immediately to Supervisor/PI
- Employees must submit the following documentation within 24 hours of an accident EVEN IF THEY DO NOT SEEK MEDICAL CARE. Failure to report an injury within this timeframe may result in denial of claim if a medical need arises at a later time
  - [Workers’ Compensation Employee Statement Form](#)
  - [Supervisor’s Accident/Incident Investigation Report Form](#)
- Student injury/accidents/exposures are not covered by Workers’ Compensation unless that student is paid by the University
  - Students must report to Student Affairs at dos@nccu.edu
- EHS and NCCU Safety Committee will conduct a de-identified incident investigation for root cause analysis

F. First Aid Exposure Response

1. Percutaneous exposure (needle sticks, cuts)
   1) Remove gloves and, if possible, force wound to bleed freely for one minute.
   2) Wash wound with soap and water for 5 minutes and, if necessary, apply sterile gauze or a bandage from first aid kit.
   3) Report to Supervisor and EHS immediately

2. Mucous Membrane Exposure:
   1) Rinse tissue surface with copious amounts of water.
2) Eyes will be irrigated for at least 15 minutes using an emergency eye wash station
3) Report to Supervisor and EHS immediately

XV. Fieldwork Safety

While having the opportunity to explore natural areas may be one of the more enjoyable aspects of research, there are certain safety concerns inherent in working outdoors. Luckily, most, if not all, of the potential safety issues can be alleviated with careful planning, common sense, and paying close attention during fieldwork. It is always advisable to avoid doing fieldwork alone.

A. Weather

In the summer and early fall, it will frequently be hot and humid. Be sure to wear sunscreen, sunglasses, a hat, and drink plenty of water. As fall moves into winter, the weather may shift suddenly and it may get cold quickly. Layering clothing is always a good idea. If weather conditions are unsafe (i.e. heavy rain, high winds, tornado watches, lightning, etc.) field work will be cancelled. However, if the day is overcast and/or drizzling the work will go on so plan accordingly.

B. Insects

Ticks, mosquitoes, bees, wasps and other biting and stinging insects are a constant presence and frequent source of annoyance to people who work outside. Besides causing itchy or painful bites, many insects also carry diseases. The best way to avoid issues is prevention. Follow these steps to minimize the chances of insect bites and stings:

1) Avoid wearing perfume, cologne, or any scented products
2) Wear long pants and close toed shoes
3) Tuck pant legs into your socks will help to prevent tick bites
4) Insect repellants containing DEET are the most effective at preventing bites, but there are other herbal products that may provide some protection if you want to avoid DEET

Be sure to check for ticks after you return from the field. The longer a tick is attached the greater the likelihood of disease transmission. To remove a tick, avoid Vaseline and recently lit match heads (a bad idea for many reasons!). Instead, the approach recommended by the CDC is to simply pull the entire tick out with tweezers. An alternative method is to coat the tick with liquid dish soap and wait 15 min; this may cause the tick to detach. If this doesn’t work, use tweezers.

C. Animals

Animals don’t, as a rule, like to be held by humans and may bite or scratch as a result. Never pick up any animal
that is not part of the research. Although venomous snakes are rare in this area, most snakes will bite and even non-venomous bites can hurt and get infected. To avoid snakebite follow these tips:

1) Never pick up or touch a snake – the majority of snakebites occur because someone handles a snake.
2) Always wear closed-toed shoes – boots are preferable to protect feet and ankles. Never place hands in an area where you cannot see – do not reach under rocks or logs.
3) Please be familiar with the venomous and non-venomous snakes in North Carolina by reviewing the fact sheet provided by the NC Poison Control. Students should be directed to immediately report any snake sightings or bites instructor.
4) The correct protocol for a venomous snakebite or suspected venomous snakebite is below: Stay calm. Call 911 or NC Poison Control at 800-222-1222.
5) Try to identify the snake by sight only. Look for color, markings and head shape. Do not try to kill the snake; it could bite again.
6) Keep the patient calm and immobile (preferably lying down). Keep the affected limb at an even level with the rest of the body. Do not use a tourniquet.
7) Do not cut the wound.
8) Do not try to suck out the venom. Do not pack the wound in ice.

Mammals can also bite and can transmit diseases including rabies. Again, prevention is the best course of action – do not pick up or touch any mammals and report all interactions and bites immediately. Raccoons, skunks and foxes are the most commonly encountered rabid animals in NC.

D. Toxic Plants

Most people are allergic to poison ivy and this allergy becomes more intense with each exposure. Just because you have not reacted previously does not mean that you will not react any given time you are exposed. Always remember “leaves of three, leave be”. Be aware that poison ivy leaves turn orange in the fall and can produce a thick hairy vine that grows on the side of trees (“only dopes touch hairy ropes).

Both the leaves and the vine produce the oily chemical that causes skin irritation and this oil remains active even after the plant dies. Poison ivy is found throughout North Carolina so be attentive to surroundings. If you are in an area with poison ivy, be sure to remove and wash clothing and shower upon returning home. If you suspect poison ivy contact, apply rubbing alcohol to the site to help minimize the reaction to the toxin. Poison sumac is a shrub or small tree that can grow as tall as 25 feet. It has red stems, along with medium-sized green leaves, which turn to a red-orange in the fall. Allergic rashes from poison sumac can range from mild to severe, and they can last for 2-5 weeks. Treat an exposure to poison sumac as you would poison ivy – wipe area with alcohol to reduce the reaction to the toxin.
E. Risk Assessment

While safety procedures or protocols for laboratory research are generally well established, resources and guidelines for field work, are usually limited to specific protocols such as sampling, etc. For researchers with limited field experience, safety planning can be particularly challenging, since it is difficult to anticipate potential hazards, let alone eliminate or control them. The checklist below can be used to identify potential hazards and guide preparation for safety in the field.

F. Mitigate hazards using hierarchy of controls

Similar to risk assessment in the lab, once potential hazards are identified the group should use the hierarchy of controls to plan controls or mitigations to limit risk and be prepared in the event of an emergency in the field.

Determine what safety equipment will be necessary and ensure it is fully functional Identify additional training that may be need to be fully prepared for field work Develop a response plan in case of an emergency Include protocols for contacting the University, family members, emergency responders, etc. Make sure you have more than one qualified driver.

G. Fieldwork Transportation

North Carolina law requires that North Carolina Motor Fleet and State-owned, passenger- vehicles be used only for official State business and be driven only by State employees with a valid driver's license. When an employee is required to use a State-owned vehicle for travel while away from his/her workstation, the vehicle may be used for travel to obtain meals and other necessities but not for entertainment or any personal purpose.

Anyone that uses their personal vehicle to transport students or other state employees to a university event will assume liability and their primary vehicle insurance will be responsible for any liability for any accident, medical or legal. State policy would only kick in if NCCU is listed in a suit.

If a student chooses to transport other students in their personal vehicles to a university event, NCCU is not liable for anything that may occur. They are assuming all of the risk.
### Fieldwork Safety Checklist

<table>
<thead>
<tr>
<th>General Considerations</th>
<th></th>
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<tbody>
<tr>
<td>How many people are needed to meet your research goals?</td>
<td>☐</td>
</tr>
<tr>
<td>To be cost effective?</td>
<td>☐</td>
</tr>
<tr>
<td>For safety?</td>
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<tr>
<td>Is work planned so that no one is working alone?</td>
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</tr>
<tr>
<td>Is there a list of safety equipment to be carried onsite (eye wash bottle, PPE, etc.)</td>
<td>☐</td>
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<tr>
<td>Does everyone have appropriate footwear?</td>
<td>☐</td>
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<tr>
<td>Does everyone carry food and water?</td>
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<tr>
<td>What physical hazards are present at the field site?</td>
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<tr>
<td>What is the likelihood that hazards might change during a work day?</td>
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<tr>
<td>What is the decision point to cancel fieldwork for the day?</td>
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<tr>
<td>Is the route into and out of the field site clear?</td>
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</tr>
<tr>
<td>For navigation do you require topographic maps? a compass? GPS unit (with extra batteries)?</td>
<td>☐</td>
</tr>
<tr>
<td>Is group trained to use map/compass/GPS?</td>
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<tr>
<td>Is anyone in the group diabetic or have severe allergies?</td>
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<tr>
<td>If so are proper medical supplies available?</td>
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<tr>
<td>Is a first aid kit available on site?</td>
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<tr>
<td>Is there more than one driver qualified and cleared to drive vehicle?</td>
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<tr>
<td>Have you checked the weather?</td>
<td>☐</td>
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<tr>
<td>Do you have plans for inclement weather?</td>
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</tbody>
</table>
XVI. Laboratory Safety Equipment

A. Eyewash and Safety Shower

Indoors, emergency eyewash and safety showers are required within 10-seconds travel distance and not more than 75 feet from where corrosive chemicals are used. These facilities must be on the same level as the chemical area; there can be no stairs/ramps or blockages between the hazard and the eyewash and/or safety shower.

Per ANSI/ISEA Z358.1-2014 plumbed eyewashes shall be activated weekly for a period long enough to verify operation and ensure that flushing fluid is available and all eyewashes shall be inspected annually to assure conformance with the standard.

The PI will ensure that this weekly operational check is performed for all eye washes/showers in their lab and/or assigned to their group and documented on the associated tag at least monthly. Annual inspections and repairs are arranged by EHS. Please notify ehs@nccu.edu immediately if any safety equipment is in need repair or service.

Signage for eye washes and safety shower stations are available from EHS.

B. First Aid Kit

The American National Standards Institute (ANSI) and International Safety Equipment Association (ISEA) – Minimum Requirements for Workplace First Aid Kits and Supplies (ANSI/ISEA Z3.8.1-2015) establishes minimum performance requirements for first aid kits and their supplies. First aid kits are classified based on the assortment and quantity of first aid supplies intended to deal with most types of injuries and sudden illnesses that may be encountered in the workplace.

Class A first aid kits provide a basic range of products to deal with most common types of injuries encountered in the laboratory including wounds, minor burns, and eye injuries.

Each laboratory must have a Class A first aid kit in a properly labeled storage location. The location of this kit is included in the lab-specific orientation training for all new laboratorians. The PI is responsible for ensuring that supplies in first aid kits are not expired and that kits are checked and re-stocked as needed. These kits are readily available from Fisher Scientific and VWR as well as other vendors.
Figure 7. ANSI Z308.1-2021 Required supplies and quantities for Class A First Aid Kits.

XVII. Disinfection

A. Surface Disinfection

The appropriate disinfectant and contact time required to inactivate infectious agents should be determined by agent-specific risk assessments. Approved laboratory disinfectants and contact times are listed in the Laboratory-Specific Safety Plan for each lab.

Contact time is the amount of time an EPA-registered disinfecting product needs to be present on a surface in order to be effective against the microorganisms listed on its label. Allowing the disinfectant to remain wet on surfaces for the appropriate contact time ensures that microorganisms are exposed to the disinfectant long enough for it to be effective against them.

Laboratory benchtops, biosafety cabinets, and equipment such as centrifuges, and balances are decontaminated...
after every use utilizing appropriate disinfectant and contact time for the lab. Exterior surfaces of incubators, cabinets, and drawers as well as floors and sinks should be cleaned and decontaminate on a regular schedule.

B. Space Disinfection

Surface decontamination of equipment and areas provides routine cleaning and disinfecting only. Vaporized hydrogen peroxide (VHP) will be used to decontaminate lab spaces or equipment as needed after significant changes in laboratory usage, prior to the initiation of significant facility repairs, or after a significantly large spill. EHS will coordinate all VHP decontamination projects. During decontamination efforts, laboratory access is restricted to protect personnel from dangerous gas.

XVIII. Autoclave Safety

Autoclave use can pose physical hazards (e.g. heat, steam and pressure) and biological hazards (e.g. improperly disinfected hazardous waste.

Full details on autoclave usage, documentation, and safety protocols are detailed in the NCCU Biological Safety Manual.

The Uniform Boiler and Pressure Vessel Act of North Carolina § 95-69.8 requires certification of all boilers-defined as “...a closed vessel in which water is heated, steam is generated, steam is superheated, or any combination thereof, under pressure or vacuum by the direct or indirect application of heat...” every two years. Certification is performed by a commissioned inspector to ensure that a boiler or pressure vessel is in compliance with the rules and regulations adopted under this Article.

Certificates for all autoclaves are inspected as part of the annual lab inspection. The PI is responsible for coordinating the installation of new autoclaves with EHS and Facilities to ensure that these are inspected and properly installed to meet compliance.

C. Training

The PI for each laboratory shall ensure that personnel have completed the NCCU Autoclave Safety Training and received training on the specific make and model used in the laboratory before loading, unloading or operating the autoclave. All training must be documented and the records maintained in the lab.

D. Performance Monitoring

Verification of autoclave performance is critical to ensure that hazardous materials are being fully decontaminated and critical lab reagents are being fully sterilized.
Heat sensitive tape is NOT an indicator of sterilization. It is a process indicator designed to change color or develop a marking once critical temperature is reached. Operators shall use heat sensitive sterilization indicator tape for each load to differentiate between autoclaved and non-autoclaved materials. Ensure that the heat sensitive tape used does not contain a lead based indicator, as this type of tape must be collected and managed as hazardous waste.

E. Biological Indicator

The NC Medical Waste Rules require that autoclaves be monitored under conditions of full loading for effectiveness weekly through the use of biological indicators. *Geobacillus stearothermophilus* indicators must be used with average spore populations of $10^4$ to $10^6$ organisms. There are many commercially available biological indicators with a choice of spore ampoules or spore strips with growth media.

Follow the instructions provided by the manufacturer of the biological indicators for storage, autoclaving, incubation and disposal. A record of each test is required using the log found in the NCCU Biological Safety Manual.

F. Chemical Indicators

Chemical indicators are used to ensure that the parameters needed to achieve sterilization of instruments or tools are met. These are NOT indicators of disinfection and should only be used if sterilization of tools or equipment are required. Chemical indicators use one or more chemicals that undergo either a physical or chemical change, that is visible to the human eye, after exposure to predetermined critical parameters such as time and temperature.

G. Autoclave Preventative Maintenance

Autoclave operators should perform the following preventative maintenance on their autoclave to maintain the autoclave's effectiveness:

- Remove the plug screen or drain strainer to make sure it is free of dirt, dust, or sediment that may collect in it and it should be cleaned as necessary.
- Clean the interior surfaces of residues collected from the steam or materials being sterilized as needed.
- Visually inspect the gaskets, doors, shelves and walls for residue buildup or wear regularly.

Manufacturer-recommended periodic inspections and preventive maintenance shall be conducted and recordkeeping shall be maintained.
H. Autoclave Failure

Discontinue use immediately if an autoclave is not working properly. Post a sign alerting others not to use the autoclave.

Mechanical failures need to be attended to by a trained technician. Contact the service company responsible for the maintenance of your autoclave or EHS for further guidance.

All failures and repairs must be documented and provided to inspectors upon request.

XIX. Laboratory Animal Safety

Personnel involved in the care and use of research animals work in an environment that presents many unique hazards related to:

- the equipment, materials and practices used in routine animal husbandry
- animal contact, directly or indirectly
- the techniques or materials (e.g., biohazardous substances) used during the course of animal experimentation

At NCCU, EHS and the Institutional Animal Care and Use Committee (IACUC) collaborate to limit exposure of personnel to the various chemical, biological and health hazards that may arise from the care and use of laboratory animals. Researchers must be trained and understand likely hazards during animal care and use. Researchers who handle research laboratory animals must complete the assigned American Association of Laboratory Animal Science (AALAS) curriculum which provides the key principles, policies, and responsibilities involved with animal-related research and teaching.

Investigators proposing work involving controlled substances and hazardous chemicals must consult with EHS regarding handling and waste management prior to submitting their protocol application to IACUC for review. All animal protocols involving the use of recombinant/synthetic nucleic acid molecules, infectious agents, genetic modifications, cell implantation or transfer, use of infectious pathogens, and toxins must be submitted to the NCCU Institutional Biosafety Committee for review and approval prior to final approval by IACUC.

Safety Data Sheets (MSDS) for all chemical agents used in the animal care operation must be available in the Animal Resource Center for review.
XX. Cryogenic Hazards

The primary hazard of cryogenic materials is their extremely low temperature. Cryogenic materials, and surfaces they cool, can cause severe burns if allowed to contact the skin. Wear insulating gloves and a face shield when preparing or using cryogenic liquids.

Use insulated gloves when handling dry ice. Add dry ice slowly to the liquid portion of the cooling bath to avoid foaming over. Avoid lowering your head into a dry ice chest: carbon dioxide is heavier than air, and suffocation can result. Do not store dry ice or liquid nitrogen in walk-in cold rooms; carbon dioxide or nitrogen can displace and thus lower the oxygen concentration in enclosed spaces.

XXI. Glassware

Accidents involving glassware are a leading cause of laboratory injuries. Use careful handling and storage procedures to avoid breaking glassware. You can prevent injuries when you use adequate hand protection when inserting glass tubing into rubber stoppers or corks or when placing rubber tubing on glass hose connections. Tubing must be fire polished or rounded, and lubricated. Hold your hands close together to limit movement of glass should it break. Consider the use of plastic or metal connectors.

Handle vacuum-jacketed glass apparatus with extreme care to prevent implosions. Tape or shield equipment such as Dewar flasks. Only use glassware designed for vacuum work for that purpose.

Provide proper instruction 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).

Glassware that is heated should be Pyrex® or a similar heat-treated type. Wear cut-proof gloves to pick up broken glass. Otherwise, sweep up small pieces with a brush into a dustpan. Dispose broken glassware in a cardboard box lined with a sturdy plastic liner marked “CAUTION: BROKEN GLASS – Non-Hazardous Materials Only”.

XXII. Tax Free Alcohol Program

NCCU has a tax-free alcohol permit, issued by the federal government, which allows scientific departments to purchase alcohol used in research without paying federal tax. Tax-free alcohol refers to ethanol/ethyl alcohol that is 190 proof or higher and regulated by the Alcohol and Tobacco Tax and Trade Bureau (TTB). This provides substantial cost benefit to the user and the University. However, there are strict federal regulations associated with the permit that are required in order to maintain the cost savings. Laboratories who use tax-free
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alcohol are required to follow specific purchasing, receiving, storage, disposal, and record keeping protocols.

North Carolina University Environmental Health and Safety (EHS) administers this program and developed Purchase & Storage of Tax-Free Pure Ethanol for Laboratory Use Guide to outline required procedures for obtaining, storing, using and disposing of tax-free ethanol found in 27 CFR Part 22.

XXIII. Hazardous Waste Collection and Disposal

At NCCU, chemical disposal is very straightforward and easy. See the Chemical Safety Plan for full details. It is against most State and Federal regulations to dispose of chemicals down the drain. Labs should submit an online Hazardous Waste Pickup Request for removal of laboratory chemical waste.

1) Labs may not accumulate more than 10 bottles of chemical waste per pickup
2) Contact EHS for handling, storage and disposal of all carcinogenic wastes

XXIV. Biohazard Waste

Biohazard waste includes:

- Materials contaminated or potentially contaminated during the manipulation or clean-up of material generated during research and/or teaching activities requiring biosafety level 1 or 2 or animal biosafety level 1 or 2
- Human liquid blood and body fluids
- Human tissue and anatomical remains
- Materials contaminated with human tissue or tissue cultures (primary and established)
- Animal carcasses, body parts, blood, fluids and bedding from animals infected with BSL2 agents

See the NCCU Biological Safety Manual for full details on collection and disposal of biohazard waste.

A. Liquid Waste

Liquid wastes are deactivated either by autoclaving or chemical disinfection using an approved, agent-specific disinfectant for the manufacturer’s recommended contact time. Most liquid wastes can be deactivated with a 1:10 final dilution (vol/vol) of household bleach – though it’s important to remember that bleach is a corrosive chemical and its use requires the availability of an eye wash within 10 seconds of travel from point of use.

Alternatively, liquid waste may be autoclaved for a minimum of 30 minutes at 121°C and 15psi
B. Solid Waste

Solid biological waste, e.g., pipettes, tissue culture flasks, and multi-well plates, is typically deactivated by autoclaving.

C. Contaminated Sharps

North Carolina law requires special handling of contaminated needles, razor blades, scalpels, lancets, syringes with/without needles, slide covers, and specimen tubes. These are collected in a red, plastic sharps containers marked with the biohazard symbol.

Red sharps containers with contaminated materials are may be disposed of in general waste AFTER being autoclaved. Prior to autoclaving sharps containers, they should be closed tightly and put into an autoclaved bag marked with heat sensitive tape to signal that the material has been decontaminated.

Sharps used to handle non-hazardous or infectious materials should be placed in white plastic sharps containers. The non-hazardous sharps containers should be disposed of in regular trash once they are 2/3 full.

XXV. Mixed Waste

Mixed wastes constitute a waste stream that contains a combination of both biological and chemical hazards in any form. Removal and disposal of mixed waste can be expensive and require special handling. Many chemicals are not appropriate for autoclaving and as such mixed wastes containing these chemicals must be handled as chemical and not biological waste:

- Phenol/Chloroform (name brand Trizol) – liquids and contaminated solids
- Bleach
- Alcohols
- Formalin/formaldehyde

If you plan to generate any mixed waste, you must contact EHS for disposal instructions prior to generation.

XXVI. Electrical Safety

Electrical equipment poses a unique set of possible laboratory hazards. Periodic laboratory inspections should pay particular attention to electrical safety.
1) All sources of electrical potential for either service or experiments must have adequate grounding and circuit breaking.

2) Review the University information sheet for Extension Cords and Power Strips and note that extension cords are only used as a temporary solution. Permanent wiring and receptacles are required for routinely used equipment or apparatus.

3) Maintain all cords and plugs in a safe condition.

4) You may use multi-outlet power strips for computer workstations, but not in any other part of the laboratory requiring multiple outlets.

Possible electrical hazards in the laboratory include:

- spliced cords;
- worn-out cords;
- inadequate strain relief for plugs (causing cord to pull away from plug housing);
- tripping hazards from poorly positioned cords;
- cords with missing ground pins;
- cords draped near hot plates or open flames; and
- cords used near sinks or other wet locations unless protected with ground fault circuit interrupter (GFCI).

XXVII. Laboratory Fire Safety

Flammable substances are among the most common hazardous materials found in laboratories. The main objective in working safely with flammable liquids is to avoid accumulation of vapors and to control sources of ignition. However, the ability of a material to vaporize, ignite or explode varies with the type or class of substance. Prevention of fires and explosions requires knowledge of the flammability characteristics (e.g. upper and lower flammability limits, ignition requirements, and burning rates) of materials encountered in the laboratory.

A. Open Flames in Labs

As a best practice, NCCU discourages the use of open flames in laboratories and encourages labs to investigate alternative methods that do not require open flames. Please contact EHS for alternatives to open flames that would best be used in the lab. Risks associated with open flames include:
• Flames near flammable solvents or other combustible materials may cause flash fires, explosion, and/or generate toxic combustion products.
• Faulty or leaky Bunsen burners or hoses can cause flammable gas leaks

Open flames in a BSC are absolutely prohibited as they have been shown to compromise both personal and product protection.

When work with an open flame cannot be avoided, labs must follow these safety measures:
• Protocol in place and trained to laboratorians
• Ensure an emergency shut-off valve is accessible and users are trained in the location and how to shut off gas
• Ensure that PPE and clothing are acceptable for working with an open flame (eye protection, no hanging clothing, long hair is pulled back and secured)
• Contact EHS for an evaluation

B. Compressed Gas

According to the OSHA Hazard Communication Standard compressed gasses are defined as:

• A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 °F (21.1 °C); or
• A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 °F (54.4 °C) regardless of the pressure at 70 °F (21.1 °C); or
• A liquid having a vapor pressure exceeding 40 psi at 100 °F (37.8 °C) as determined by ASTM D-323-72.

Persons working in laboratories where compressed gasses are stored or used are required to take the one-time Compressed Gas Training and pass the associated quiz.

Compressed gases can cause fires, explosions, oxygen deficient atmospheres, toxic gas exposures as well as the innate physical hazard associated with cylinders under high pressure. Special storage, use, handling and disposal procedures are necessary to ensure the safety of researchers using these chemicals and equipment. Compressed gas cylinders can present a variety of hazards due to their pressure and/or contents.

Principal Investigators are responsible for assuring that the requirements of this section are followed by all persons under their supervision who use or handle compressed gas cylinders. All compressed gases must be
included in the laboratory’s chemical inventory and on the lab door signage.

**General cylinder safety**

- Accept only properly identified cylinders and do not rely on color codes
- If a cylinder or valve is noticeably corroded, the vendor should be contacted for instructions
- A leaking cylinder should be removed and isolated in a well-ventilated safe area. If this occurs, immediately notify EHS or University Police after hours.

**Storage, Use and Handling**

1. Properly secure cylinders in a well-ventilated and protected area away from heat, flames, and the sun
2. Segregate cylinders by hazard class while in storage
3. Discontinue use of the cylinder when it has at least 25 psi remaining; close valve to prevent air and moisture from entering. Return unused and empty cylinders to the vendor
4. All empty cylinders must be marked “EMPTY”
5. All compressed gas cylinders must bear labels that clearly identify the contents
6. Compressed gas cylinders must be in an upright position and supported at all times, whether full or empty Acceptable methods of support include:
   a. wall-mounted or bench-mounted gas cylinder brackets;
   b. chains or belts anchored to walls or benches; and
   c. free-standing dollies or carts designed for gas cylinders and equipped with safety chains or belts.
7. Gas cylinders must have the valve protection cap in place except when in use
8. Use appropriate dollies or hand trucks to move cylinders
9. Pressure regulators and gauges must be compatible with the cylinder valves

C. Properties of Flammable and Combustible Substances

1. Liquids

The **flash point** is the lowest temperature determined by standard testing at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid within the test vessel. Many common laboratory solvents and chemicals have flash points that are lower than room temperature.

It is actually the vapor, not the liquid, that will cause burns. The rate at which different liquids produce flammable vapors depends on their vapor pressure. The degree of fire hazard depends also on the ability to form combustible or explosive mixtures with air.
## Laboratory Safety Manual

### Version #2.0

<table>
<thead>
<tr>
<th>Flammable liquids</th>
<th>Boiling point</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flash Point</strong></td>
<td><strong>Boiling point</strong></td>
</tr>
<tr>
<td>≤ 100 °F (3.78 °C)</td>
<td></td>
</tr>
<tr>
<td>Class IA</td>
<td>below 73 °F (23 °C)</td>
</tr>
<tr>
<td>Class IB</td>
<td>below 73 °F (23 °C)</td>
</tr>
<tr>
<td>Class IC</td>
<td>73-100 °F (24-38 °C)</td>
</tr>
<tr>
<td><strong>Combustible liquids</strong></td>
<td></td>
</tr>
<tr>
<td>≥ 100 °F (3.78 °C)</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>101-140 °F (39-60 °C)</td>
</tr>
<tr>
<td>IIIA</td>
<td>141-199°F (61-93°C)</td>
</tr>
<tr>
<td>IIIB</td>
<td>200°F (93°C) or above</td>
</tr>
</tbody>
</table>

### 2. Solids

The United States Department of Transportation (DOT) in 49 CFR 173.124 defines and classifies flammable solids in one of three categories:

- **Class 4, Division 4.1: Flammable Solid**
  - Self-reactive materials that are thermally unstable and can undergo a strongly exothermic decomposition even without participation of oxygen; desensitized explosives also fall within this category.

- **Class 4, Division 4.2: Spontaneously Combustible Material**
  - Pyrophoric (air-reactive) materials or self-heating materials, likely to self-heat when in contact with air and without energy supply.

- **Class 4, Division 4.3: Dangerous when wet material**
  - Liable to spontaneously combust or give off flammable/toxic gas when in contact with water.

### 3. Gases

Flammable gases are classified as Class 2, Division 2.1 materials defined by DOT in 49 CFR 173.115 as gases in

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that are:

- Gases at 20° C (68° F) or less and 101.3 kPa (14.7 psi) of pressure, **AND**
- Are ignitable at 101.3 kPa (14.7 psi) when in a mixture of 13 percent or less by volume with air; **OR**
- Have a flammable range at 101.3 kPa (14.7 psi) with air of at least 12 percent regardless of the lower limit.

D. Ignitability

The **auto-ignition temperature** of a substance, whether solid, liquid or gaseous, is the minimum temperature required to initiate self-sustained combustion independent of the heat source. A steam line or a glowing light bulb may ignite carbon disulfide (ignition temperature 80°C [176°F]). Diethyl ether (ignition temperature 160°C [320°F]) can be ignited by the surface of a hot plate. Silane gas (ignition temperature 21°C [69.8 °F]) can spontaneously ignite at or near room temperature.

**Spontaneous ignition or combustion** takes place when a substance reaches its ignition temperature without the application of external heat. Consider the possibility of spontaneous combustion, especially when materials are stored or disposed. Materials susceptible to spontaneous combustion include oily rags, dust accumulation, organic materials mixed with strong oxidizing agents (such as nitric acid, chlorates, permanganates, peroxides and persulfates), the alkali metals (lithium, sodium, potassium, rubidium, and cesium), finely divided metal powders, and phosphorus.

E. Sources of Ignition

Many potential sources of spark, flame, or heat in laboratories can ignite flammable substances, such as open flames, static electricity, lighted matches and hot surfaces. When flammable materials are in use, pay close attention to all potential ignition sources in the vicinity. The vapors of flammable liquids are heavier than air, and can travel considerable distances. Recognize this possibility and take special note of ignition sources at a lower level than the level of flammable liquid use.

Flammable vapors from substantial sources such as spills can descend into stairwells and elevator shafts and ignite on a lower story. If the path of vapor is continuous, the flame can propagate itself from the point of ignition back to its source.

Properly bond and ground all metal lines and vessels dispensing flammable substances to discharge static electricity. When nonmetallic containers (especially plastic) are used, the bonding can be made to the liquid rather than to the container.
F. Use of Flammable Substances

The basic precautions for safe handling of flammable materials include the following:

1) Handle flammable substances only in areas free of ignition sources.
2) Do not heat flammable substances with an open flame. Preferred heat sources include steam baths, water baths, oil baths, heating mantles and hot air baths.
3) When you transfer flammable liquids in metal equipment, avoid static-generated sparks by bonding, and the use of ground straps.
4) Ventilation is one of the most effective ways to prevent the formation of flammable mixtures. Use an exhaust hood when you handle appreciable quantities of flammable substances (e.g. transferring between containers or in an open container, especially if you are heating it).
5) When withdrawing a flammable liquid from a drum, or filling a drum, both the drum and other equipment must be individually, electrically grounded and bonded to each other.
6) Containers of flammable liquids shall not be drawn from or filled within buildings without provisions to prevent the accumulation of flammable vapors in hazardous concentrations.

G. Storage of Flammable Substances

Guidelines for safe storage of flammable materials include the following:

- Store flammable and combustible liquids only in approved containers. Containers used by the manufacturers of flammable and combustible liquids generally meet these specifications.
- Flammables stored in the open laboratory are kept to a minimum
- Safety refrigerators labeled for lab use only are recommended. This equipment has the electrical contacts removed or exteriorized.
- Domestic refrigerators in labs must have signage which states that no flammable storage is permitted.
- Explosion-proof refrigerators are rarely necessary and should be clearly labeled as explosion proof
- Do not locate flammable storage near an exit or in a hallway.
- Keep flammable liquids away from heat and direct sunlight.
- Store flammable liquids in a way that prevents accidental contact with strong oxidizing agents
- Maximum allowable size of containers for flammable and combustible liquids are set by NFPA and shown below
The potential fire hazard is also dependent on the total quantity of flammable and combustible liquids present within a given space. The maximum quantity allowed per laboratory unit is as follows:

- **Open shelving or storage - approved plastic or metal:** 10 gallons (37.9 liters)
- **Safety can:** 25 gallons (94.7 liters)
- **Approved storage cabinet**
  - Class I: 30 gallons (113.6 liters)
  - Class I, II, & III: 60 gallons (227.2 liters)
- **Inside storage room that meets NFPA Code**
  - Sprinklered: 4-10 gal/ft²
  - Non-sprinklered: 2-4 gal/ft²

**H. Fire Extinguishers**

[Portable Fire Extinguisher Training](#) is required upon initial employment and at least annually thereafter to meet regulatory requirements. Initial training is included in the [Orientation to the Laboratory Environment](#) provided to new laboratorians. Training provides a greater insight into portable fire extinguishers for employee use, general principles of fire extinguisher use, hazards involved with using extinguishers to fight fires, and information on what types of portable fire extinguishers are on campus as well as how to select the proper type of extinguisher.
<table>
<thead>
<tr>
<th>Type</th>
<th>Materials</th>
<th>Description</th>
<th>Label</th>
<th>Pictogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Ordinary Combustibles</td>
<td>Fires in paper, cloth, wood, rubber, and many plastics require a water or dry chemical type extinguisher</td>
<td>![A]</td>
<td>![fire]</td>
</tr>
<tr>
<td>B</td>
<td>Flammable Liquids</td>
<td>Fires in solvents and other flammable liquids require dry chemical, or CO₂ extinguisher</td>
<td>![B]</td>
<td>![fire]</td>
</tr>
<tr>
<td>C</td>
<td>Electrical Equipment</td>
<td>Fires in wiring, fuse boxes, energized equipment and other electrical sources require a dry chemical or CO₂ extinguisher</td>
<td>![C]</td>
<td>![electricity]</td>
</tr>
<tr>
<td>D</td>
<td>Metals</td>
<td>Combustible metals such as magnesium and sodium require special extinguishers</td>
<td>![D]</td>
<td>![metal]</td>
</tr>
<tr>
<td>K</td>
<td>Cooking Oils and Fats</td>
<td>Wet chemical extinguishers specially designed to put out fires of cooking oils or fats; unlikely needed in a laboratory setting.</td>
<td>![K]</td>
<td>![cooking]</td>
</tr>
</tbody>
</table>

Most chemical laboratory fire hazards require multipurpose dry chemical extinguishers (ABC) located in hallways. “Gas” extinguishers containing carbon dioxide (CO₂) offer a first defense against flammable liquids or electrical fires without leaving a powder residue that could harm electronic equipment. Class D extinguishers are also located in select labs, they can be identified by label and color (yellow).

EHS coordinates monthly checks of all fire extinguishers. Please report any problems or missing extinguishers to ehs@nccu.edu.

XXVIII. Minors and High School Students in Laboratories

The concern of NCCU for laboratory safety extends not only to laboratorians but also to any persons visiting laboratories including our visiting high school students. Laboratories are common sources of thermal dangers, compressed gases, electrical hazards, chemical, and biological materials, lasers, and sharp objects.
All minors on campus are protected by NCCU Regulation 80.07.1 Protection of Minors on Campus. This Regulation establishes requirements that all activities, events, or programs that involve the participation of minors must adhere to. Failure to comply with the requirements set forth in this Regulation may lead to disciplinary action and/or revocation of the opportunity to use University facilities.

Information for personnel interested in sponsoring minors to participate in research programs or mentoring is provided in the NCCU Minors in Laboratories Document Packet.
XXIX. Appendix A Delegated Authority Memorandum

TO: All NCCU Faculty and Staff
FROM: Ms. Akua J. Mathering, CPO & Vice Chancellor for Administration and Finance
CC: Dr. Johnson O. Akinleye, Chancellor
DATE: January 11, 2023
RE: University Compliance with Environmental Health and Safety

As the University continues its' growth and development through research, infrastructure, enrollment, other enhancements and improvements, safety and compliance remain of paramount importance. We are extremely pleased with the safety and regulatory programs that have been developed by the department of Environmental Health and Safety over the last three years. EHS Director Dr. Kristin Long-Witter and her team of talented subject matter experts have worked diligently to implement critical safety and regulatory programs across campus. The EHS team has not only worked to establish these critical programs to protect faculty, staff, students, and scholarship, but also developed internal training and modules to educate and inform as to the necessity of these programs.

While some components of compliance may be viewed as tedious, a single OSHA fine can be in the hundreds of thousands of dollars and failure to comply with federal regulations can result in loss of federal funding to the University. Those are risks that NCCU is not willing to accept, and we thank EHS for their commitment to understanding the regulations and ensuring university wide compliance.

Every member of the University community must understand that environmental health and safety is not an additional responsibility, but rather an integral part of every task they perform. All Eagles share the responsibility of maintaining a safe and healthy community to work, learn, and live in.

The University expectation is that all NCCU faculty, staff, and students engage in a program of voluntary compliance with applicable federal, state, local regulations and NCCU regulatory documents. Safety and compliance must be enforced on campus, the authority is delegated to the EHS Director, Dr. Kristin Long-Witter and her team. The delegation includes the following:
Enforcement of all health, safety and related regulatory compliance mandates under EHS purview with penalty or administrative sanction as prescribed by regulation or regulatory document imposed at their discretion.

The authority to curtail or stop work posing a clear and imminent danger (condition or practice which could reasonably be expected to cause death or serious physical harm immediately unless actions are taken to mitigate the effects of the hazard and/or remove employees from the hazard) to the health or safety of the University community.

Going forward, departments that do not comply or respond timely and potentially jeopardize the University will be subject to the authority and actions listed above, without question. It is the University's duty to remain fully compliant and it is my responsibility as CFO and Vice Chancellor of Administration and Finance to ensure that this happens. Please remember that EHS is here to advocate for your safety and to ensure that NCCU remains a safe, compliant place to work, learn and grow. Thank you.