This chapter lists and describes several major categories of hazardous materials and/or hazardous operations that you could work with in your lab. For each category, the chapter includes recommended safe work practices and regulatory requirements (if applicable).

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I. Safety Awareness

Everyone involved in laboratory operations – from the highest administrative level to the individual workers – must be safety minded. Safety awareness can become part of everyone’s habits only if senior and responsible staff demonstrates a sincere and continuing interest in safety, and discusses it repeatedly. Over-familiarity with a particular laboratory operation may result in overlooking or underrating its hazards. This attitude can lead to a false sense of security, which frequently results in carelessness. Be alert to unsafe conditions and actions and call attention to them so that one can make corrections as soon as possible. Every laboratory worker has a basic responsibility to himself/herself and colleagues to plan and execute laboratory operations in a safe manner.

II. Unattended Operations

Frequently, laboratory operations must run continuously or overnight. Equipment and experiments that run unattended during the day or overnight can cause significant problems and harm to personnel, facilities, and equipment. If unattended operations are necessary, it is essential to plan for potential interruptions in utility services such as electricity, water and inert gas. Make sure you perform a hazard analysis to identify potential consequences of failures in utility services or equipment. Design operations to be “fail-safe”, so that one malfunction will not cause a propagation of additional failures.

If necessary, arrange for routine inspection of the operation. If appropriate, leave laboratory lights on during unattended operations, and place a sign on the entrance door. Appendix 3-C is an example sign for unattended operations. You can use this design, or a similar type, to convey critical information to personnel (such as other lab personnel, maintenance, housekeepers, or incident responders) who could encounter your unattended operation. Contact EHS if you have any questions.

Frequently Asked Questions about Unattended Operations

Q. What is meant by “unattended operation”?
A: For the purposes of this section, an unattended operation is any unmonitored lab activity that has the potential to release water, gas, chemical substances, electrical energy, or chemical energy during foreseeable failures of equipment or utility services.

Q. Which types of unattended operations would require door signage?
A: Any unattended operation which could potentially harm personnel (such as maintenance workers or housekeepers) due to contact during normal operation or failure; or which could cause substantial damage to property or the environment during failures.
• Should stay attended, but would certainly require a door sign if unattended.
• The hot plate could burn to the touch.
• In the event of flask breakage, a fire could start if a flammable solvent such as hexane or petroleum ether is in use.
• A rupture of the condenser water line could flood the lab or rooms below.

Q: **What are some examples of “fail-safe” designs?**
A: Fail-safe designs help ensure that a failure will leave the experiment unaffected, or convert it to a state that minimizes injury or damage. Examples include:

• Water flow monitors and solenoid valves that shut off water to a condenser in the event of water line rupture
• Temperature-sensing monitors that turn off power to hot plates or vessels if the temperature exceeds a pre-set limit for any reason
• Automatic gas shutoff valves that shut off gas flow in the event of a power outage, leak, or significant seismic event

## III. 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 in University buildings. Store, handle, and consume food and drink items in areas free of hazardous substances. Consider designating non-laboratory areas, such as nearby break rooms, lounges or conference rooms, as food storage and eating areas for laboratory personnel.

When you establish food areas within laboratory spaces, observe the following rules:
A. Establish well-defined, fully outlined areas (including desks, cabinets, microwaves and refrigerators) within the lab space.

B. Clearly post a sign designating the food item area(s) and instructing that no radioactive, chemical, or infectious materials are permitted. *(Example Sign)*

C. Food item areas must be at least three feet from a laboratory work area or chemical storage area. In some instances, EHS may permit, upon evaluation, less than three feet if an appropriate barrier is in place. In other cases, three feet may be inadequate to prevent contamination of food items, e.g., laboratory operations with a high potential for aerosolization and volatilization of chemicals, radioactive materials, or biological materials. EHS does not permit food areas in rooms with such operations. The design of some laboratories may not allow for the designation of food areas.

D. 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.

E. Do not use laboratory refrigerators, ice chests, and cold rooms for food storage. Use separate, dedicated equipment with prominent labels that state “Food/Drink Use Only” or similar wording.

F. Designated food item areas must be free from all research-related items, including personal protective equipment (e.g. lab coats, gloves, safety glasses). Laboratories can post this sign to remind personnel.

G. Do not allow any chemical, radioactive, or biological materials storage above a designated food item area.

**IV. Housekeeping**

Safety performance 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.

**V. Working Alone**

Avoid performing experiments alone in a laboratory building. Arrange with individuals working in separate laboratories outside of working hours to cross check periodically. Alternatively, UNC Police can check on laboratory workers. Do not undertake experiments known to be hazardous when alone in a laboratory.

Under unusual conditions, special instructions may be necessary. The Principal Investigator must determine whether the work requires special safety precautions, such as having two persons in the same room during a particular operation.

**VI. Hazard Information Signs and Placards**

Post laboratory areas that have special or unusual hazards with hazard information signs and labels. Standard signs and symbols exist for a number of special situations, such as radioactive materials, radiation hazards, biological hazards, fire hazards and laser operations. Other signs shall be posted to show the locations of safety showers, eyewash stations, exits and fire extinguishers. Fire extinguishers are to be labeled to show the type of fire for which they are intended. A green on white placard must be posted to designate emergency eyewash and shower facilities. Waste containers must be labeled for the type of waste for which they are intended. The safety- and hazard- sign systems in the laboratory should enable a person unfamiliar with the
VII. Labels on Chemical Containers

Label all containers of hazardous materials to identify the contents. University labeling requirements and guidelines include the following:

• Inspect incoming containers of hazardous chemicals to ensure that containers have legible labels.
• If you receive a new chemical (one not previously used in your laboratory), retain the Safety Data Sheet (SDS) for the laboratory file, unless your lab prefers to maintain SDSs electronically. Inform laboratory personnel about the hazards of the chemical. See Chapter 1 of this Manual for information on obtaining SDSs.
• If the composition of a chemical produced in the lab is unknown, assume it is hazardous.
• If you produce a chemical for another user outside the lab, you must comply with the provisions of 29 CFR 1910.1200, including preparation of an SDS. Contact EHS for assistance.
• Clearly spell out the name of the chemical on the label any time you transfer substances from original containers to secondary containers, or when synthesizing/mixing new substances, if the substances are not for the immediate use of the handler or preparer. Do not use molecular formulas as sole identification. For example, do not write H2SO4 only on a label to identify the contents as sulfuric acid. The label must read “Sulfuric Acid”.
• In the case of buffer solutions, it is appropriate to identify the contents as “Buffer Solution” and include the type of buffer in its abbreviated form (e.g. “Buffer Solution – Tris”). Consult the EHS Safety Labels webpage for examples.

VIII. Eyewash and Safety Shower Facilities

Indoors, emergency eyewash and safety showers are required within 10-seconds travel distance and not more than 75 feet from where toxic chemicals are used. These facilities must be on the same level as the chemical area; there can be no stairs or ramps between the hazard and the eyewash and/or safety shower. Units must be plumbed units that meet the ANSI Standard Z358.1 (Figure 3.2).
Some field operations and other locations where plumbing connections are not available might require a non-plumbed unit (Figures 3.3a and 3.3b). Do not use these non-plumbed units in areas where plumbed units can be installed. Non-plumbed units are available that meet the ANSI requirements for flow and duration (1.5 liters/0.4 gallons per minute for 15 minutes). However, non-plumbed units are more difficult to maintain. Their solutions require frequent changing per manufacturer’s instructions. Because most non-plumbed units do not have a significant reserve capacity, you must refill them after every use or test to ensure they maintain the required minimum flow and duration.

Hand held drench hoses in laboratories are a supplement, but not a substitute, for an eyewash and safety shower. Personal eye flush squeeze bottles (Figure 3.3c) do not meet ANSI requirements, because they cannot deliver the required minimum flow rate and duration. EHS discourages the presence of these bottles in your lab because they have a limited shelf life, are prone to contamination, and are ineffective at dual-eye or eye-face irrigation.

Because some chemicals, even in small amounts, can irritate or damage skin upon contact, flush affected areas with water as soon as possible. Remove personal protective equipment and clothing in the areas of chemical contact once you or your co-workers have activated the shower. Fellow workers may need to help remove contaminated clothing. Call 911 if immediate medical attention is necessary. Contact the University Employee Occupational Health Clinic (919-966-9119) immediately. Remain in the shower or continue flushing the eyes for no less than 15 minutes.

Each research group is responsible for ensuring that emergency eyewash facilities, both within its laboratory space and in nearby common areas, remain operational and accessible. Check the system at least once a month. A quick (~5 second) activation of the eyewash verifies water pressure, and flushes rust, scale, and other debris out of the system. Perform these checks on all eyewash facilities that your research group might
use, even if the facilities are located in common areas outside the group’s lab room(s). Verify monthly eyewash checks by filling out inspection tags located on or near the units. After performing the monthly check, make sure that water does not remain on the floor to create a slip hazard for personnel. This is an especially important consideration for eyewash facilities located in common corridors and that lack floor drains. For these facilities, use buckets, secondary containment trays, or other collection devices to prevent discharge of water directly onto the floor.

Facilities Services checks safety showers and has the equipment necessary to contain, collect, and cleanup the large volume of water discharged by a safety shower test.

**IX. Maintenance Personnel**

Laboratory research may also expose maintenance, housekeeping, and other support personnel to potential physical and chemical hazards in the laboratories. You can keep their exposure risk to a minimum by proper labeling of waste containers (refer to Chapter 12) and decontaminating equipment before servicing. Before requesting service of laboratory equipment by maintenance personnel complete and attach a Safety Clearance Form (Appendix 3-A) to the equipment.

When you surplus laboratory equipment you must affix the “Surplus Property” version of the Safety Clearance Form. This is an orange adhesive label with the same information as the paper version but it will not fall off in transit. Call EHS (919-962-5507) to request these labels. The University will pick up surplus property; however, personnel will not pick up laboratory equipment without the proper “Surplus Property” label. Check with your business office for current surplus procedures.

**X. Equipment Decontamination**

The following are some general decontamination guidelines. Refer to the [Radiation Safety Manual](http://unc.policystat.com/policy/5891211/) for questions concerning radioactive contamination. Refer to the [Biological Safety Manual](http://unc.policystat.com/policy/5891211/) for questions concerning biological contamination. Contact EHS if you have additional questions about equipment decontamination.

- Safely remove, drain, or discharge chemicals from the equipment, collecting the chemicals for re-use or hazardous waste disposal.
- If applicable, use an inert gas or liquid (i.e. triple rinse) to purge the chemical residues. In some cases, the rinsate might require disposal as hazardous waste.
- For equipment with non-permeable surfaces, decontaminate by scrubbing with warm, soapy water.
- For equipment that also might contain biological contamination, follow the soapy water wash with a 1:10 bleach solution soak. Rinse the equipment after at least 10 minutes contact time with the bleach.

**XI. Machine Guarding**

All mechanical equipment must be equipped with guards that prevent access to electrical connections or moving parts (such as the belts and pulleys of a vacuum pump). Inspect equipment before use to ensure that the guards are in place and functioning. Careful design of guards is vital. An ineffective guard can be worse than no guard at all, because it may give a false sense of security. Emergency shutoff devices might be necessary, in addition to electrical and mechanical guarding. Contact EHS if you have questions or concerns about guarding.
XII. Safety Shielding

Use safety shielding for any operation having the potential for explosion such as:

- When performing a reaction for the first time (use small quantities to minimize hazards)
- When a familiar reaction is carried out on a larger than usual scale (e.g., 5-10 times more material)
- When you carry out operations under non-ambient conditions; place shields to protect all personnel in the area from the hazard

XIII. Compressed Gases

The use of compressed gases on campus is to be in accordance with recommendations published by the Compressed Gas Association. The following rules summarize basic guidelines for the use and storage of compressed gases:

A. All compressed gas cylinders must bear labels that clearly identify the contents.

B. Compressed gas cylinders must be supported at all times, whether full or empty (Figure 3.5). Acceptable methods of support include:

1. wall-mounted or bench-mounted gas cylinder brackets;
2. chains or belts anchored to walls or benches; and
3. free-standing dollies or carts designed for gas cylinders and equipped with safety chains or belts.

Make sure that any chains, belts, or wall anchors supporting multiple cylinders have the strength to support the weight of the entire potential load. Do not overload support systems.
C. Gas cylinders must have the valve protection cap in place except when in use. A cylinder connected to a piece of equipment and properly supported is “in use”. Remove the pressure regulators and replace valve protection caps before moving cylinders, even if you have secured the cylinders to a dolly or hand truck. For example, do not transport acetylene and oxygen cylinders, used for cutting and brazing with regulators attached to the cylinders, except in the cylinder cart.

D. Post all hydrogen and/or acetylene storage and usage locations with permanent placards that read: “HYDROGEN/ACETYLENE – FLAMMABLE GAS – NO SMOKING – NO OPEN FLAMES.”

E. Gas cylinders must be in an upright position and clamped securely at all times. Because of the extreme hazards created by using certain cylinders in a horizontal position (e.g., acetylene), you must consult EHS before using cylinders in any position other than vertical, with the valve up.

F. Use appropriate dollies or hand trucks to move cylinders weighing more than 50 pounds. Do not move cylinders by spinning, sliding, rolling, etc. For movement within shops and laboratories, one may carry cylinders weighing less than 50 pounds, if desired.

G. Keep cylinders of all gases having a health hazard rating of three or four, such as ammonia, carbonyl sulfide, hydrogen cyanide, hydrogen sulfide, methylamine, and nitric oxide, in hoods or other enclosures that vent directly outside. Each hood or enclosure may not have more than three cylinders of this type. Provide appropriate and clearly marked first aid, antidote information, and supplies at room entrances. Safety data sheets must be available, either in hard copy or electronic format.

H. Installed piping systems for flammable gases, toxic gases and oxygen must be in accordance with OSHA, NFPA, and ANSI standards and approved by EHS.

I. Pressure regulators and gauges must be compatible with the cylinder valves. You may not use “cheaters” (adapters) instead of the correct regulator and gauge.

J. All oxygen valves, gauges, regulators, pipes and fittings must be scrupulously free of oil, grease, graphite or any other oxidizable substance. For this reason, do not use soap-based leak detectors on oxygen cylinder regulators or fittings. Oxygen pipes, gauges, fittings, etc., must not reach elevated temperatures due to proximate welding operations, burners or other heat sources. Although oxygen is quite safe under normal temperatures and pressures, elevated temperatures and/or pressures (or contamination) may result in the rapid and violent oxidation of normally non-reactive materials. For example, a regulator used in oil-pumped nitrogen could produce a serious explosion if subsequently used for oxygen, due to the oil contamination.
K. There are two general types of compressed gas cylinders: returnable (owned by the gas supplier, demurrage charged to the University) and non-returnable. Most suppliers will accept the return of their cylinders even if they are not empty (pressure approaching atmospheric). However, suppliers will not accept non-returnable cylinders under any circumstances. Disposal of non-returnable cylinders containing highly toxic or reactive gas can be very expensive. Therefore, purchase compressed gases in returnable cylinders if available.

XIV. Systems Under Pressure

Do not carry out reactions in, or apply heat to, a closed system apparatus unless it is designed and tested to withstand pressure above atmospheric. Pressurized systems must be equipped with an appropriate relief device. If you cannot open the reaction directly to the air, use an inert gas purge and bubbler system to avoid pressure buildup.

XV. Cold Traps and 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. Do not use liquid nitrogen or liquid air to cool a flammable mixture in the presence of air, because oxygen can condense from the air and lead to an explosion hazard. Read Appendix 3-B (Cryogenic Hazards) for more information.

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.

XVI. 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 (e.g., leather or Kevlar® gloves) 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.

Do not attempt glass-blowing operations unless proper annealing facilities are available.

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 gloves, preferably leather, when you pick up broken glass. Otherwise, sweep up small pieces with a brush into a dustpan. Dispose broken glassware in a special container marked “CAUTION: GLASS AND SHARPS – Non-Hazardous Materials Only” (available on EHS Safety Labels page). Refer to the section in Chapter 12 entitled Disposal to
Treat broken thermometers as hazardous waste. Refer to the mercury disposal and cleanup section in Chapter 1 for further information.

**XVII. Needles and Sharps Safety**

Needlestick injuries and cuts are frequent occurrences in laboratories. For needles contaminated with a toxic chemical or pathogenic organism, the consequences can be serious. You can reduce the likelihood of injuries by limiting the use of syringes and needles. Consider finding alternative procedures or use of a blunt needle. Other safety precautions include:

- Do not recap needles.
- Do not remove needles from syringes.
- Do not bend, break, or otherwise manipulate needles.
- Discard in puncture resistant containers.

Razor blades are common in laboratories, and are another potential source of injury. Keep razor blades sheathed when not in use. If your lab uses blades that do not have sheaths, use a Styrofoam block, adhesive tack, or other material to prevent exposure to blades between uses. Do not store these blades unprotected on countertops, or in drawers where personnel could reach in and cut their hands. Dispose these blades in appropriate sharps containers; see Chapter 12: Management of Laboratory Wastes for further guidance.

**XVIII. Electrical Safety**

Electrical equipment now comprises a major part of the modern laboratory, thus posing a new set of possible laboratory hazards. Periodic laboratory inspections should pay particular attention to electrical safety. Incorporate electrical safety into the initial design and setup of laboratory equipment and apparatus. You must install and maintain all new electrical equipment, whether permanent or temporary, in accordance with the provisions of the latest edition of the National Electric Code (NEC) NFPA 70. Every replacement, modification, repair, or rehabilitation of any part of any electrical installation must comply with NEC standards.

**Proper Wiring**

Only Facilities Services may authorize modifications or changes to circuits or building equipment. All sources of electrical potential for either service or experiments must have adequate grounding and circuit breaking. University policy allows flexible extension cords only as temporary extension cords for portable equipment. Permanent wiring and receptacles are required for routinely used equipment or apparatus. Maintain all cords and plugs in a safe condition. You may use multi-outlet power strips for computer workstations, but not in any other part of the laboratory requiring multiple outlets. In this case, Facilities Services must install additional hard-wired outlets. A list of possible wiring hazard follows:

- 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
- cords used near sinks or other wet locations unless protected with ground fault circuit interrupter (GFCI).
COPY

Grounding and Bonding

You must ground all exposed non-current-carry metal covers and other parts that are liable to energize. This includes the chassis of refrigerators, freezers, centrifuges, etc. When you transfer flammable liquids in metal containers, avoid static generated sparks by bonding between containers with the use of ground straps.

Isolation

Power sources must be isolated to prevent accidental contact, which could result in serious electrical shock. Take the following precautions to isolate power sources.

A. Ensure a labeled switch is in a readily accessible location for shutting off the power to laboratory equipment or apparatus in case of emergency. Make sure that all switches are accessible and not blocked by other equipment or lab clutter.

B. All electrical equipment or apparatus requiring frequent attention must be electrically isolated with a fused disconnect switch.

C. Enclose all power supplies for experiments, so that accidental bodily contact with power circuits is impossible. Access doors must have interlocks. Even for temporary arrangements, enclosures are required.

D. Use lockout and tagout on appropriate disconnect switches to de-energize electrical power to equipment being worked on. A lockout/tagout system makes it impossible to energize a piece of equipment while the lock/tag is in place. Use a voltage tester to ensure the correct circuit is “dead.”

You should never work alone around energized electrical equipment. Know the procedure for removing a person from contact with a live electrical conductor, and the emergency first-aid procedures for persons who receive a serious electric shock.

Ground Fault Circuit Interrupters (GFCI): Additional Information

GFCI detect ground faults, also known as leakage currents, and in response open the circuit to halt the flow of electricity. GFCI can protect you if part of your body becomes a path for electrical current to ground. The leakage current threshold that “trips” a GFCI is typically five milliamps (5 mA). This is much lower than the threshold to trip a typical non-GFCI circuit breaker (usually at least 15 amps). GFCI can protect both equipment and personnel, whereas circuit breakers can only protect equipment. (Figure 3.7a)

GFCI outlets usually have two small buttons labeled “TEST” and “RESET” in the center (Figure 3.7b). Outlets located near sinks or other wet locations are to be GFCI outlets. Some circuits have GFCI protection at the
circuit breaker, rather than the outlet; thus, the outlet might look like a non-GFCI version but the circuit is GFCI protected. Functional GFCI systems ensure that the worst result if one becomes a path to ground is a brief 5 mA shock, which is painful but not fatal.

Keep in mind that GFCI circuits trip more frequently than non-GFCI. De-energization of experimental apparatuses could damage equipment, destroy research, or even cause accidents (e.g. spills or releases). Consider the potential consequences of de-energization before using GFCI circuits, especially for operations you leave unattended. Fail-safe designs might be necessary.

Contact EHS if you have questions about areas that might require GFCI protection. Contact Facilities Services to have GFCI outlets installed, or to report GFCI outlets that trip frequently. Alternately, you can plug GFCI adapters (Figure 3.7c) or GFCI cords (Figure 3.7d) into non-GFCI outlets in wet locations. Note that flexible extension cords (including GFCI cords) are for short-term use with portable equipment, and are not a substitute for permanent wiring.
**Electrical Fires**

Poor contacts at electrical connections and overloaded circuits can cause fires. Poor contacts between plugs and receptacles can cause arcing, which could lead to serious fire hazards. Overloaded circuits can cause fire by overheating. Extension cords or cube taps can overload circuits. Multi-outlet boxes with built-in switches, pilot lights, circuit breaker, and reset provide better protection than cube taps.

Disconnect electrical soldering irons, hot plates, and other electrical heating equipment when not in use. Use fire-resistant metal sheets under heating equipment to protect work surfaces. Electric heating equipment should be equipped with a temperature-sensing device that turns off the electric power if temperature exceeds the preset limit.

Unattended overnight operations (see Section II) of electric heating devices, stills, etc. should incorporate fail-safe devices that sense temperature, flow, liquid level or electrical overload. You should only use hot plates for heating liquids with flash points above 100 °C. Steam baths are required for heating liquids with low flash points, e.g., ethyl ether.

You must plug all electrical equipment used in a laboratory hood into a receptacle outside the hood. Rheostats used to control equipment in a laboratory hood must be located outside the hood, as it is a spark-producing device that is not constructed to protect against liquid splashes or spills.

**Explosive Atmospheres**

Specially designed electrical equipment is necessary in areas where hazardous mixtures of explosive gases, vapor, or dusts are present (Article 500, National Electrical Code). Explosion-proof equipment, intrinsically safe circuits, purged enclosures, and positive-pressure ventilation are appropriate for operations in hazardous location. Some examples are:

- Flammable liquid storage rooms
- Flammable compressed gas storage rooms
- Motors and stirrers for solvents and oil baths
- Centrifuges using flammable liquids
- Refrigerators for storing flammable liquids
- Walk-in environmental chambers (i.e., cold or warm rooms)

**XIX. Storage in Buildings with Sprinkler Systems**

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.

**XX. High School Students and Minors in Laboratories Policy**

The concern of UNC-Chapel Hill (“University”) for laboratory safety extends not only to employees but also to
Appendices

Appendix 3-B: Cryogenic Hazards

Follow these necessary precautions:

- Know the first aid procedures for frostbite before using, handling, or storing a cryogenic liquid.
- Keep flammables and combustibles well away from liquefied oxidizing gases. For example, under suitable conditions, steel burns when in liquid oxygen.
- Avoid pouring a cryogenic liquid on or over the edge of a glass Dewar flask when filling or emptying the flask; the flask may break and implode.
- Do not put a cryogenic liquid into a household Thermos bottle or other insulated container ordinarily used to keep food or drinks cold.
- When using, handling, or storing cryogenic liquids, wear a laboratory coat without pockets (or at least without outside pockets) or wear a laboratory apron. Wear cuffless pants and high-topped leather shoes; to deflect any spills, the bottoms of the pants should cover the tops of the shoes. Remove watches, rings, and other jewelry.
- The eyes are particularly vulnerable to harm from exposure to cryogenic liquids. Wear both Type G, H, or K safety goggles and a Type N face shield when using, handling, or storing cryogenic liquids.
- If it is necessary to handle chilled parts of the apparatus, consider wearing insulating gloves. If the gloves become contaminated with an oxidizing cryogenic liquid, handle the gloves as though they are flammable for at least 24 hours.
- Avoid skin contact with cryogenic liquids. Even a very brief contact can result in severe frostbite and/or torn flesh.
- Laboratory workers who use, handle, or store toxic cryogenic liquids and all others in the area should wear appropriate respiratory equipment.
- Avoid inhaling air that has been cooled to near-cryogenic temperatures.
- The chilled vapors from evaporated cryogenic liquids tend to accumulate in pits and low-lying areas. These gases are of course invisible and have partially or completely displaced oxygen from the areas they occupy. Do not enter such areas without wearing an oxygen-supplying respirator.
- Never transport cryogenic liquids in an elevator. In the event of elevator malfunction, the resulting collection of evaporated gas in the elevator shaft from the cryogenic liquid could be disastrous*. Even a so-called closed Dewar has a pressure relief valve that can release evaporating vapors.
- Many solids become brittle and fragile at cryogenic temperatures. Before allowing an unfamiliar solid to be chilled to cryogenic temperatures, learn its properties at such temperatures.
- Immediately evacuate any area in which there is an uncontrolled release of a cryogenic liquid or vapor.

For more information, see Alaimo’s *Handbook of Chemical Health and Safety* and the Compressed Gas Association’s *Safe Handling of Cryogenic Liquids*.

Adapted from *Safety in Academic Chemistry Laboratories, American Chemical Society, 7th Ed.*

*If accumulated in an elevator shaft, nitrogen and other inert gases are asphyxiants; accumulations of oxygen and other oxidizing gases can cause spontaneous ignition and explosion; and accumulations of flammable gas...
are explosive.

**Additional Appendices**

- Appendix 3-A: Safety Clearance Form
- Appendix 3-C: Unattended Operation - Example Sign

Back to [Chapter Two](#)

Proceed to [Chapter Four](#)

All revision dates: 1/22/2019, 1/7/2019, 1/2/2019, 7/1/2014

**Attachments**

- Appendix 3-A: Safety Clearance Form
- Appendix 3-B: Cryogenic Hazards
- Appendix 3-C: Unattended Operation Example Sign

**Approval Signatures**

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<td>1/22/2019</td>
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