CHEMICAL HYGIENE PLAN

Department of Chemistry and Biochemistry

University of Northern Colorado
Fall 2020

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Preamble

The Culture of Laboratory Safety[1]

As a result of the promulgation of the Occupational Safety and Health Administration (OSHA) Laboratory Standard (29 CFR § 1910.1450), a culture of safety consciousness, accountability, organization, and education has developed in industrial, governmental, and academic laboratories. Safety and training programs have been implemented to monitor the handling of chemicals from the moment they are ordered until their departure for ultimate disposal and to train laboratory personnel in safe practices.

Laboratory personnel realize that the welfare and safety of each individual depends on clearly defined attitudes of teamwork and personal responsibility and that laboratory safety is not simply a matter of materials and equipment but also of processes and behaviors. Learning to participate in this culture of habitual risk assessment, experiment planning, and consideration of worst-case possibilities—for oneself and one's fellow workers—is as much part of a scientific education as learning the theoretical background of experiments or the step-by-step protocols for doing them in a professional manner. [2]

A crucial component of chemical education at every level is to nurture basic attitudes and habits of prudent behavior so that safety is a valued and inseparable part of all laboratory activities. In this way, a culture of laboratory safety becomes an internalized attitude, not just an external expectation driven by institutional rules. This process must be included in each person's chemical education throughout his or her scientific career.

Responsibility and Accountability for Laboratory Safety[3]

Ensuring a safe laboratory environment is the combined responsibility of laboratory personnel, EHS personnel, and the management of an organization, though the primary responsibility lies with the individual performing the work. Of course, federal, state, and local laws and regulations make safety in the laboratory a legal requirement and an economic necessity. Laboratory safety requires mandatory safety rules and programs and an ongoing commitment to them. Direct responsibility for the management, implementation, and operation of the Departmental laboratory safety program rests with the chemical hygiene officer (CHO) and the safety committee; responsibility for working safely, however, lies with faculty, students and others who actually do the work.

A person from the Department Safety Committee is recommended to the Department Chair for the role of Chemical Hygiene Officer. The CHO must serve a minimum of two years in the role in order to learn the duties and responsibilities of the position. No term limits on the position exist and continued service in the role is at the discretion of the Department Chair. The choice to begin or

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[1] *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards.* National Research Council: The National Academies Press, Washington, D.C., 2011, p.2.

[2] In regard to safe use of chemicals, the Department distinguishes between *hazard*, which is an inherent danger in a material or system, and the *risk* that is assumed by using it in various ways. *Hazards* are dangers intrinsic to a substance or operation; *risk* refers to the probability of injury associated with working with a substance or carrying out a particular laboratory operation. For a given chemical, risk can be reduced; hazard cannot.

[3] *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards.* National Research Council: The National Academies Press, Washington, D.C., 2011, p.2 - 3.

continue the service of a particular CHO should not be taken lightly as the CHO represents and ensures the maintenance of safety within the Department. Should the Department Chair not approve the choice of CHO from the Safety Committee, the Safety Committee will elect one of its members to serve (the same person may be elected by the Safety Committee should the committee disagree with the Chair about appointing their initial choice.)

Laboratory instructors, coordinators, and research mentors carry direct responsibility for safety of the students in the laboratory. They are responsible for promoting a culture of safety as well as for teaching the requisite skills needed to handle chemicals safely.

Should laboratory instructors, coordinators or research mentors not adhere to the safety practices outlined in this plan, they will be asked to correct those practices by the CHO and/or Department Chair. Should that not correct the issue, it is the responsibility of the CHO and Department Chair to collectively determine the penalty. That penalty can range from recording the issue in annual reviews (at a minimum) to banning the use of laboratory facilities. Penalties for students, graduate or undergraduate, who fail to follow the guidelines in this document are outlined in the following section.

Introduction to the Chemical Hygiene Plan

Safety should always be of the utmost concern for anyone working in the laboratory. The safety policies contained in this Chemical Hygiene Plan (CHP) are written in accordance with the Department of Chemistry and Biochemistry's commitment to safety. At the end of selected sections are specific procedures for students, laboratory instructors, and researchers (undergraduate students, graduate students and faculty).

For teaching laboratories, the laboratory instructor needs to be cognizant of what is considered to be an unsafe action or whether policy is being adhered to, and he or she has the authority to require a student to leave the laboratory.

If appropriate, the laboratory instructor may pursue further disciplinary action. If there is a dispute on the action taken by the laboratory instructor, the student may appeal the decision to the laboratory coordinator (defined here as the faculty member in charge of all sections of that laboratory course).

A student researcher who does not follow the policies in this manual is subject to disciplinary action by the student researcher's primary advisor. Primary investigator(s) for each research laboratory must review the policies in this document and append the specific requirements for the appropriate research laboratory. The director(s) of each research laboratory must prepare Standard Operating Procedures (SOPs) for all laboratory procedures not covered in this general CHP (see p. 22). Copies of the SOPs must be maintained in the main office as current as possible.

It is the responsibility of any person in the laboratory to notify the proper authority in the appropriate hierarchical order, first the laboratory instructor, then the laboratory coordinator, the research advisor, and finally the department chair if unsafe laboratory conditions exist or if a possible safety concern is present. This statement will be inserted into all syllabi with the laboratory coordinator's name.

General Laboratory Safety

General Information

Laboratories in which chemicals are used must have access to safety showers, eyewashes, fire extinguishers, fume hoods, and sinks. Safety showers and eyewashes must be free of obstructions in order to be accessed easily and quickly.

Laboratory Use

Laboratories at UNC have two primary functions: teaching and research. Undergraduate students are permitted in teaching laboratories only when there is direct or indirect supervision. When teaching laboratories are not in use, the doors to the laboratory must be locked. When a teaching laboratory is in use, all corridor entrance doors to the laboratory must be unlocked to give full access to the room.

Research laboratories should never be left unlocked when unattended for any period of time. Undergraduate researchers must not work in an unsupervised research laboratory alone. When graduate students are using a research laboratory, there must be another person on the floor who knows that the student is in the laboratory in case of an emergency. Graduate researchers must let another person know when they are going to be in a research laboratory alone.

Eye Protection

The only approved goggles that may be used in chemistry laboratories at UNC are either indirectly vented or unventilated chemical splash goggles that meet the standard set by the American National Standards Institute (ANSI) Z87.1-2003, for protection from chemical splash; safety glasses or other forms of eye protection may not be substituted for splash goggles. If there is confusion as to whether goggles are department-approved, the laboratory coordinator or research mentor should be consulted.

Goggles must be worn in the teaching laboratories <u>at all times</u> as per the laboratory instructor's directions. If a visitor enters a laboratory when chemicals are in use, the visitor is required to wear department-approved goggles while in the laboratory.

Contact Lens. Students who wear contacts must place a clearly visible red dot on the left side of the goggles, so that in the event of an accidental spill, instructors and students will know that the person involved may need help removing their contacts before the eyes can be flushed with water.

RESPONSIBILITIES

STUDENTS: It is the student's responsibility to purchase goggles and wear them when they are in the laboratory according to the laboratory instructor's directions. If a student wears contact lenses, it is the responsibility of the student to inform the laboratory instructor so that a red dot can be placed on the goggles.

LABORATORY INSTRUCTORS: It is the laboratory instructor's responsibility to purchase and wear goggles and to enforce the use of goggles while every laboratory session is in progress. As

good practice, the laboratory instructors should remind the students to don their goggles immediately after the pre-lab lecture.

RESEARCHERS: It is the researcher's responsibility to purchase their own goggles and wear them whenever they are in a research laboratory. There is no *safe* location in the research laboratory where goggles are not required. In addition, red dots must be placed upon the goggles of researchers who wish to wear contact lenses in the laboratory.

Clothing, hair, and jewelry

Appropriate clothing must be worn in laboratories at all times, regardless of whether an experiment is being performed or not, to offer protection against chemical spills and splashes. Appropriate clothing is defined as loose-fitting cotton or cotton-based fabrics that cover the entire body from the ankles to the neckline and at a minimum with sleeve-lengths that at least cover the shoulders. Clothing that is appropriate laboratory attire does not have holes of any size – whether designed that way or not.

Specifically, shirts must cover the entire torso area, from the neckline to the waist, and have sleeves that cover the shoulders. The shirt must not constrict the body or expose skin on the abdomen or back when the person moves their arms above their head. Sleeves must also not be so loose that they pose a hazard in and of themselves.

Appropriate pants cover the entire lower portion of the body to the ankle; shorts or mid-length pants are not appropriate attire in laboratories. While not recommended, if a skirt or dress is worn in the laboratory, it must be at least mid-calf in length and the remainder of the leg covered by socks and not stockings, leggings, etc. Leggings, leotards, capris, yoga-pants, and other similar pants are NOT appropriate attire and should not be worn in the lab. Legwear such as this does not afford appropriate absorptive protection from spills and often does not have sufficient cotton content to avoid melting when on fire.

Shoes appropriate for the laboratory must completely cover the feet from the ankle down. No woven shoes, sandals, high heels, or open-toe shoes may be worn in the laboratory.

Long hair and loose clothing must be tied back, out of the way of chemicals or fire.

Jewelry should not be worn in the laboratory, as chemicals can seep under a ring or bracelet. In addition, jewelry can get caught on equipment or come into contact with an electrical hazard.

RESPONSIBILITIES

STUDENTS: It is the student's responsibility to come to the laboratory in the appropriate lab attire and, if applicable, with properly restrained long hair.

LABORATORY INSTRUCTORS: It is the laboratory instructor's responsibility to ensure that all students in a laboratory are wearing appropriate attire, that long hair is restrained, and that all jewelry that can cause safety or health concerns is removed. If a student is not in compliance with any of these policies, it is the instructor's responsibility to ensure that the student corrects the infractions in order to remain in the laboratory. The instructor should dismiss the student from the laboratory if these policies are not met. If there is a dispute on whether certain articles or accessories are approved attire, the laboratory coordinator should be consulted.

RESEARCHERS: Appropriate clothing is to be worn in research laboratories at all times.

Face coverings and masks

The Department, College, or University, from time to time, may require that face coverings be worn as protection during a health crisis or for other reasons. In such cases, all faculty, staff, and students in the Department will comply with those orders. Unless defined by the College or University otherwise, the Department defines "face covering" as surgical masks, particulate (N95) masks, or any covering made from a minimum of two layers of woven fabric. Coverings should be free of holes of any size. Proper use of the covering is such that it covers the nose and mouth at all times and that the covering is held in place securely and tightly to the face. Because contamination of a covering by transfer of chemicals from the hands to the covering may be possible, the wearer should avoid touching or adjusting the covering once it is in place unless they thoroughly wash their hands prior to doing so.

The Department designates the proper wearing of an approved face covering as essential Personal Protective Equipment (PPE). As noted elsewhere in the Chemical Hygiene Plan, failure to wear appropriate PPE as required for the course or as determined by the University may result in dismissal from a specific meeting time, dismissal from a course, or expulsion from all courses.

The Department recommends the following statement be included on all laboratory course syllabi:

The Department requires Personal Protective Equipment (PPE) to be worn in laboratories at all times. Currently, PPE is defined as both Department-approved splash goggles, appropriate attire, and face coverings (surgical masks, particulate (N95) masks, or double-layer cloth masks). Failure to wear the required PPE properly at any time while you are in Ross Hall may result in your dismissal from this course. Additional information can be found in the Department's Chemical Hygiene Plan available at https://www.unco.edu/nhs/chemistry-biochemistry/important.aspx.

The Department recommends the following statement be included on all lecture/seminar course syllabi:

The Department requires appropriate Personal Protective Equipment (PPE) to be worn in all public spaces at all times. Currently, the Department has defined PPE to include Department-approved face coverings (surgical masks, particulate (N95) masks, or double-layer cloth masks). Failure to wear the required PPE properly at any time within Ross Hall may result in your dismissal from this course. Additional information can be found in the Department's Chemical Hygiene Plan available at https://www.unco.edu/nhs/chemistry-biochemistry/important.aspx.

Gloves and Lab Coats

Gloves provide an extra level of protection while using chemicals, but with this added protection comes the possibility of further safety and health concerns. Simple checks can assure that appropriate gloves are being used. 1) Use a proper reference and determine the type of gloves to use that will provide protection against the chemical(s) being handled (see Table 1). The wearer is responsible for checking to see that the gloves have no holes or cracks in them; if any crack or hole exists, the gloves' protective properties are reduced greatly, and they should not be used.

Glove use can lead to accidental exposure of chemicals to others. *Gloves should be removed before moving to a different room, opening doors or drawers, using writing instruments, telephones, and other equipment.* Gloves provide protection against chemicals that are being handled, but chemicals

can be easily be spread if gloves are not removed immediately after their use and cleaned or disposed of properly.

Gloves can provide protection against hazardous chemicals; however, certain chemicals can diffuse through gloves and be held against the skin causing health concerns. Select the appropriate gloves to ensure that the gloves provide protection against chemicals being used. **CAUTION!** While wearing gloves, it is possible that one will not notice when accidental exposure has occurred. To reduce a chance exposure, do not touch hair, clothing, or any portion of the face (especially the eyes). If there is a possibility that exposure has occurred while wearing gloves, remove the gloves immediately and rinse the exposed area of the hand with running water, and seek assistance as needed.

Lab coats may be worn in teaching laboratories. Wearers are responsible for purchase and care of their own lab coat. Lab coats must be removed before leaving the lab.

Glove Material	Applications*
Butyl	A synthetic rubber material that offers the highest permeation resistance to gas and water vapors. Especially suited for use with esters and ketones.
Neoprene	A synthetic rubber material that provides excellent tensile strength and heat resistance. Neoprene is compatible with some acids and caustics. It has moderate abrasion resistance.
Nitrile or Latex	A synthetic rubber material that offers chemical and abrasion resistance, a very good general duty glove. Nitrile also provides protection from oils, greases, petroleum products, and some acids and caustics.
PVC	A synthetic rubber thermoplastic polymer that provides excellent resistance to most acids, fats and petroleum hydrocarbons. Good abrasion resistance.
PVA	A water-soluble synthetic material that is highly impermeable to gases. Excellent chemical resistance to aromatic and chlorinated solvents. This glove cannot be used in water or water-based solutions.
Viton7	A fluoroelastomeric material that provides exceptional chemical resistance to chlorinated and aromatic solvents.
SilverShield	A lightweight, flexible laminated material that resists permeation from a wide range of toxic and hazardous chemicals; virtually no cut resistance.
4H7	A lightweight, patented plastic laminate that protects against many chemicals. Good dexterity.

****This table is provided only as a guide. Note that chemical compatibility of a given glove can vary among manufacturers.***

RESPONSIBILITIES

STUDENTS: Gloves will be provided for those experiments deemed necessary but the student must purchase and care for his/her own lab coat.

LABORATORY INSTRUCTORS: If gloves are to be used in a laboratory, special attention needs to be given to those who are using the gloves to ensure that the accidental spread of chemicals does not occur.

RESEARCHERS: Gloves and lab coats should be used as needed. Questions about use of extra protection should be referred to the research advisor.

Additional Policies

Everyone working in a chemical laboratory should be aware of the dangers of ingesting or absorbing chemicals. These common-sense precautions must be followed in laboratories or other spaces where chemicals are stored at all times regardless of whether an experiment is being performed or not.:

a. Do not consume food or beverages in any laboratory. If sealed food or beverage in containers is brought into a laboratory, it should be left in a "cubby" in the lab. Food or beverage should never be placed on a lab bench. Any consumption of food or beverage must occur outside the laboratory.
b. Do not smoke, use smokeless tobacco, or chew gum in any laboratory.
c. Do not apply cosmetics when in the laboratory.
d. Wash hands and arms thoroughly before leaving the laboratory, even if gloves have been worn.
e. Do not leave a laboratory or use instruments with gloves on. Gloves should always be removed and discarded in the trash can before leaving a laboratory or before using instruments that will be handled by people that will not be wearing gloves.
f. Wash lab coats or jackets separately from personal laundry.
g. Never wear or take lab coats or jackets into areas where food is consumed.
h. Never pipet by mouth; always use a pipet aid or suction bulb.

Pregnancy Policy

A chemical may pose a hazard to both an adult and an unborn fetus. Students who are pregnant or think that they might become pregnant or are attempting become pregnant (regardless of gender) during the course should discuss their enrollment in the course with their physician(s). Particular attention should be given to the materials used in this course. A current list of the materials used in each course is available from the Laboratory Coordinator and can also be found in the lab manual for that course. Material safety data sheets (MSDSs) and Safety Data Sheets (SDSs) are available for all chemical materials used in each course and can also be easily found online.

Should the physician feel that participation in the course is still appropriate, the physician will provide a letter stating their approval for the student to remain in the lab and participate in the experiments. In addition, a list of the specific PPE (manufacturer and model number) that the student should wear will be provided by the physician. That copy should be provided to the TA (who will provide copies for the Lab Coordinator and Chair of the department). The student will not be admitted to the lab unless that specific PPE is properly worn at ALL times. The acquisition and cost of the PPE will be borne by the student.

Service Animals

The safety of a service animal is the responsibility of the caretaker of that animal. The owner of any service animal must provide leather booties and a blanket for the animal to rest upon. The animal must rest in an area removed from any work on a bench or hood. Failure to provide care for any service animal according to these rules will result in prohibiting admission into the laboratory for the animal and the caretaker.

Laboratory Upkeep: Housekeeping, Glassware, and Equipment Use

General Laboratory Upkeep

Cleanliness leads to a safer and more efficient work environment. For example, laboratory drawers should be closed when not in use, for they can pose a potential hazard for others who enter the lab. All laboratory equipment must be used in accordance to the manufacture's specifications. When finished using a piece of equipment, it should be returned in the same condition in which it was found, making sure that no safety concerns are present. Chemicals must be returned to their appropriate storage location immediately after use. All safety showers and eyewashes should be activated weekly by staff and inspected according to ANSI standards by Environmental Health and Safety or campus Facility Operations to ensure proper operation in the case of emergency. Likewise, fume hoods should be inspected annually by Facilities (see p. 17).

RESPONSIBILITIES

STUDENTS: It is the student's responsibility to keep his or her work area clean while in the laboratory. Laboratory drawers that are assigned must be kept closed when not in use. Chemicals should never be kept inside student laboratory drawers.

LABORATORY INSTRUCTORS: It is the laboratory instructor's responsibility to enforce the policy and thus ensure that a safe laboratory is being kept at all times.

RESEARCHERS: Upkeep of individual research laboratories is expected. Chemicals must not be stored in closed cabinets or drawers for any reason.

Cleaning Glassware

Dirty glassware should never be allowed to accumulate in large quantities in any laboratory. It should be cleaned daily at the very least. Sinks should have rubber mats on the bottom of them to help prevent the breakage of glassware, but the mats should not block or prevent the normal flow of water through the drain. Gloves and goggles should be used when cleaning glassware, even when no apparent hazard is present.

Glassware should be cleaned with warm water and soap or detergent. Strong cleaning agents such as nitric, chromic or sulfuric acid or other strong oxidizers should be avoided if possible. If it is imperative to use a strong oxidizer as a cleaning agent, another person should be present in the laboratory in case of accident, and the person cleaning the glassware must be trained in handling strong oxidizers.

Cleaned glassware should be dried on a drying rack, or oven if appropriate for the particular laboratory. Once dried, the glassware should be stored in its proper location; the drying rack is not a storage location. In no case should drying glassware be left on the bench within 6" of the edge.

If glassware is broken in a teaching laboratory, the laboratory instructor should be notified immediately. If a chemical spill has occurred as well, see the appropriate section in this manual for handling spills. Once chemicals have been dealt with appropriately, the broken pieces should be collected using a broom and dustpan and disposed of in a broken glass disposal box. DO NOT DISPOSE OF BROKEN GLASS IN THE REGULAR TRASH! When the broken glass disposal box is full, it should be securely taped and labeled as trash for the custodial services to pick up.

RESPONSIBILITIES

STUDENTS: Students are required to clean all glassware that they use. Broken glassware must be reported to the instructor for cleanup procedure. Students may use only mild soaps or detergents when cleaning glassware; under no conditions should students use strong oxidizers for this purpose.

LABORATORY INSTRUCTORS: It is the laboratory instructor's responsible to enforce the policy.

RESEARCHERS: Extreme caution should be used when using strong oxidizers as cleaning agents. Undergraduate researchers should not use oxidizers as cleaning agents unless a graduate researcher or professor is present.

Instruments and Equipment

Before using any instrument or equipment, the student or researcher must be properly trained by a qualified graduate student, faculty member, or the Stockroom Manager. Undergraduate students and undergraduate researchers must get authorization from a the qualified graduate student, faculty member or the Stockroom Manager before using any instrument and equipment. Failure to seek proper authorization may result in dismissal from the laboratory and loss of the privilege to use instrumentation and equipment.

Wiring on electrical equipment should be examined to ensure that no exposed wires or possible dangerous condition exists. Any equipment that has potentially dangerous wiring should not be used. Use equipment only in accordance with manufacturer's specifications. When using equipment that emits heat, be sure no combustible material is near.

Do not leave equipment unattended when in use; the operator or another person should always be in the laboratory. If equipment must to be left unattended for a period, check the equipment periodically. If applicable, let another person know that equipment is being left unattended so that he or she can monitor it. When leaving a reaction overnight (e.g., a reflux), leave a note on all doors of the laboratory indicating that an experiment is being conducted, the location, details of the reaction, contact numbers, and possible hazards that could result.

Refrigerators in laboratories are for chemicals, never for food. Volatile solvents requiring refrigeration must be stored in explosion-proof refrigerators.

Compressed Gases

Compressed gases have the potential to be very dangerous missiles if handled improperly. All cylinders, regardless of size, must be restrained at all times using straps, chains or in the case of lecture bottles, a stand. Protective caps (shipping caps) must be properly installed on compressed gas cylinders at all times when not in use. If a cylinder must be moved, the protective cap must be secured in place over the valve. Transport of that cylinder, unless it is a lecture bottle, requires the appropriate use of a cylinder cart with the cylinder strapped in place.

All cylinder valves must be tightly closed when not in use. Any regulator must not be left under pressure when the gas is not being used. As with all work in the laboratories, appropriate goggles must be worn when working with compressed gases.

Dispensing Liquid Nitrogen (LN_2)

Liquid nitrogen is an asphyxiant and a cryogen and must be handled carefully. Persons who use LN_2 must be trained before dispensing and using it. LN_2 can cause tissue damage by contact, and boil-off or a spill can cause asphyxiation. Should LN_2 be needed for an experiment or demonstration off-campus, any person handling it MUST be trained in its safe use and transport. The Chair of the Department will verify all training before any LN_2 is dispensed for use off-campus. Under no circumstances should LN_2 be transported within a closed vehicle.

MSDS and Chemical Classification

Material Safety Data Sheet (MSDS)

The stockroom maintains a file containing Material Safety Data Sheets (MSDS) for every chemical used in the teaching laboratories. It is the responsibility of each research laboratory supervisor to maintain a similar MSDS file for those compounds stored or used in their own research spaces. The MSDS file should be organized alphabetically and stored in the research laboratories so that the sheets should be easily accessible to everyone. The MSDS file should be updated as often as possible to ensure that the most current safety and health information is available in the case of an accident.

MSD sheets, irrespective of their source, generally contain the following information:

1. **Product Identification**
   Synonyms
   CAS number
   Molecular Weight
   Chemical Formula
2. **Composition**
   Ingredients
3. **Hazard Identification**
   Emergency overview
   Health, flammability, and instability rating
   Protective equipment
   Storage code
4. **First Aid Measures**
   Inhalation
   Ingestion
   Skin contact
   Eye contact
   Physician notes
5. **Fire Fighting Measures**
   Fire
   Explosion
   Fire extinguishing media
   Special information
6. **Accidental Release Measures**
   Ventilate area

Wear appropriate personal protective equipment

7. **Handling and Storage**
   Wear appropriate personal protective equipment such as goggles, gloves, and an apron
8. **Exposure Controls and Personal Protection**
   Airborne exposure limits
   Ventilation system
   Personal respirators
   Skin protection
   Eye protection
9. **Physical and Chemical Properties**
   Appearance
   Odor
   Solubility
   pH
   Boiling point
   Melting point
   Vapor density
   Vapor pressure
   Evaporation rate
10. **Stability and Reactivity**
    Hazardous decomposition products
    Hazardous polymerization
    Incompatibilities
    Conditions to avoid
11. **Toxicological Information**
    LD50 information
    Cancer lists.
12. **Ecological Information**
    Environmental fate
    Environmental toxicity
13. **Disposal Considerations**
    Recommended disposal methods
14. **Transport Information**
    Shipping classification
15. **Regulatory Information**
    Federal, state, and international regulations
16. **Other Information**
    NFPA ratings
    Label hazard warnings
    Label precautions
    Label first aid information
    Product use
    Revision information
    Disclaimer

Hazard Classifications

The most widely used method of classifying the hazard that a chemical possesses utilizes a numbering system in multiple categories: Toxic, flammable, reactive, corrosive. Two hazard

classifications, NFPA and HMIG (see below), are used in the Department. However, it is the responsibility of the users of the specific chemicals to consult the MSDS sheets, or other information, for a thorough understanding of the hazards associated with the use of any material. All researchers should be aware that there are many other types of hazards in a laboratory. Additional information may be found in *Safety in Academic Laboratories,* American Chemical Society, 7th ed, vol 1 (Students), pp. 10 – 25, and vol 2 (Faculty and Administration), pp. 15 - 28.

Laboratory Signage and Labels

Laboratory signage should be clear, readable, and conspicuous. In all teaching laboratories the Hazardous Materials Identification Guide (HMIG) system is used to communicate hazards (Fig. 1) and each laboratory has a large HMIG sign for reference. This system uses blue for Health, red for Flammability, and Yellow for chemical Reactivity and a rating system for each category from 0 = minimal to 4 = extreme. Personal protective equipment (PPE) is specified by a code (Fig. 1). Labels on chemical bottles must reflect the same categories.

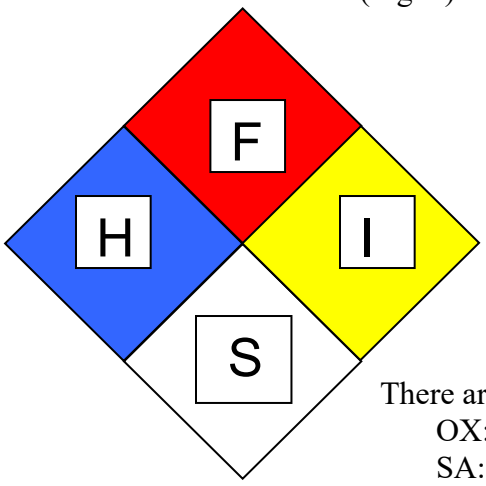
FIGURE 1

NFPA Hazard Identification Placards

The National Fire Protection Association has developed a system for indicating the toxicity (**H**ealth), ignitability (**F**lammability), **I**nstability (formerly "reactivity), and **S**pecial (corrosivity, chemical reactivity) hazards of a chemical. The hazards are rated with 0 as the least, and 4 as a significant hazard. Following NFPA standards, UNC's Environmental Health and Safety office places NFPA signs by the entrance doors to the laboratories (Fig. 2).

Hazard ratings:
0 least

4 greatest



There are 3 NFPA-approved "Special" Hazards
OX: Oxidizer
SA: Simple asphyxiants
~~W:~~ Unusual reactivity with water

FIGURE 2

Bear in mind, however, that the NFPA symbol is *not* intended to inform chemists or chemistry students but is intended for fire fighters who are facing the possibility of a chemical fire. For safety information about a chemical, the MSDS and the HMIG labeling system are the primary resources.

Chemical Handling Protocols

Arrival of New Chemicals

All new chemicals are to be ordered through and delivered to the chemical stockroom. No chemical is to be ordered without completion of the appropriate order form using the procedure outlined below. The process for that ordering is:

a. determine the suitable source of funds for the purchase of the chemical
b. complete the yellow intra-Departmental order form and obtain the purchaser's and Department Chair's signature (used to verify the funds exist in the charged account)
c. deliver the yellow form to the stockroom
d. the stockroom will then order the chemicals as dictated on the form
e. the stockroom will then notify the person who ordered the chemicals after they have arrived and been inventoried appropriately.

When a new chemical arrives, it will be tagged by stockroom personnel with a chemical inventory label and entered into the inventory system with the date of arrival. Once a chemical has been inventoried, it is the responsibility of the primary user to determine where it will be housed and to inform the Stockroom Manager of the specific location (room and shelf number). It is the responsibility of the primary user to then maintain that chemical in its storage location and report to the Stockroom Manager when the chemical has been completely used.

RESPONSIBILITIES

STUDENTS: Students are not responsible for the pickup and placement of new chemicals.

LABORATORY INSTRUCTORS: Normally the Stockroom Manager is responsible for the placement of new chemicals in teaching laboratories. In cases where new laboratory experiments are being developed, it is the responsibility of the laboratory instructor to place new chemicals after they arrive and have been inventoried.

RESEARCHERS: Either a graduate researcher or professor should pickup and determine the placement of new chemicals; undergraduate researchers are not responsible for this task.

Using Chemicals

The MSDS should be consulted before using any chemical, and all necessary precautions and safety equipment must be utilized when handling chemicals. A spill must be cleaned up immediately to avoid possible exposure to others, see the section on chemical spills.

After a chemical is used, the bottle should be returned to its storage location, logged when the chemical first arrived at UNC. If for some reason during the use of a chemical its inventory barcode is lost or destroyed, the researcher is responsible for reporting this to the Stockroom Manager so that a new barcode can be placed on the bottle and the old registration number removed from the data base.

When the bottle is fully depleted, the bottle should be cleaned without destroying the stockroom inventory barcode. Then the empty bottle should be delivered to the stockroom, so that the chemical can be removed from the inventory.

Storage of Hazardous Materials

In all case, the Stockroom Manager, faculty, and researchers should avoid the accumulation of excess chemicals by acquiring the minimum quantities necessary for each procedure or research project and by disposing of unused and unwanted supplies in a timely and appropriate fashion.

No more than 1.0 L of any flammable chemical may be kept at a workbench at any given time. Excesses of this limit are to be stored in approved storage cabinets as described below. In no case should storage be allowed directly on the floor. The total volume of all flammable liquids within a particular laboratory should be maintained at levels less than 60 L if at all possible.

Flammable liquid chemicals in bottles containing more than 500 mL should be stored in sealed containers within cabinets designated as flammable storage cabinets. All flammable storage cabinets must be clearly marked as such and conform to appropriate safety protocols for flammable storage (metal wall construction with spring loaded doors). All doors to flammable storage cabinets should be closed when not in use. Non-flammable liquids in bottles containing more than 500 mL are permitted to be stored on shelves outside of the flammable storage cabinets.

All chemicals must be stored according to their chemical reactivity; oxidizers are stored with oxidizers, reducers are stored with reducers, etc. All attempts will be made to ensure that classifications of compounds dictate storage procedures (for example, the Fisher Chemical Storage method). In no case should incompatible compounds be stored within the same location. A list of incompatibilities in Figure 3 is below:

Incompatibilities by Hazard Class

	Acids, Inorganic	Acids, Oxidizing	Acids, Organic	Alkalis (Bases)	Oxidizers	Poisons, Inorganic	Poisons, Organic	Water-Reactives	Organic Solvents
Acids, Inorganic			X	X		X	X	X	X
Acids, Oxidizing			X	X		X	X	X	X
Acids, Organic	X	X		X	X	X	X	X	
Alkalis (Bases)	X	X	X				X	X	X
Oxidizers			X				X	X	X
Poisons, Inorganic	X	X	X				X	X	X
Poisons, Organic	X	X	X	X	X	X			
Water Reactives	X	X	X	X	X	X			
Organic Solvents	X	X		X	X	X			

X Indicates incompatibility between two chemical product groups. Incompatible products should not be stored in close proximity.

FIGURE 3

All cylinders of gases are to be securely stored in designated areas. In no case should a gas cylinder be stored without a securing strap, nor should a gas cylinder be stored on a cylinder cart.

All severe toxins are to be stored in locked cabinets. In no case should the lock on the cabinet be left unlocked for a period longer than is needed to add or remove chemicals from the cabinet.

Refrigerated storage should be used for some chemicals. In that case, flammable materials must be stored in designated flammable-storage refrigerators. Highly reactive compounds that must be refrigerated must be stored in designated explosion proof refrigerators. As noted in the Prudent Practices in the Laboratory manual, the Department will take every effort to phase out the spark-proof refrigerators in exchange for the more desirable explosion-proof refrigerators.

Transporting Chemicals

When a chemical is exhausted its container should be returned to the stockroom to be removed from inventory. When chemical refills are needed in a teaching laboratory, a student or instructor delivers the empty bottle to the stockroom. Once the bottle has been refilled or replaced, a member of the stockroom personnel or the instructor will return the chemical to the teaching laboratory. Under no circumstances should a student be responsible for the transport of chemicals to the teaching laboratory; students may transport only empty chemical bottles or storage containers.

Researchers are responsible for the transport of chemicals to and from their laboratory. Only graduate students, professors, or the Stockroom Manager should transport hazardous materials.

When hazardous chemicals are being transported, the container-within-a-container method is the preferred method of transport. Bottles of chemicals are not to be transported by hand due to the risk of accidentally dropping the bottle causing a chemical spill. Appropriate safety equipment must be worn when transporting hazardous chemicals. Refer to the chemical MSDS for appropriate transport specifications.

Disposing of Chemicals

Reaction Products, By-products, and Unreacted Starting Material

The disposal of any and all products, by-products, unreacted starting material, or other chemical is one of the more critical aspects of maintaining a safe laboratory. It is the responsibility of every person in the laboratory to dispose of his or her own chemicals in a safe, approved fashion, in accordance with federal and local regulations.

If products or by-products produced in a reaction are classified as hazardous material, i.e., material that cannot be disposed of in the sewer system, the compounds are to be placed in a labeled container. Similar products that pose no safety hazard if mixed, see Figure 3, and do not cost more for disposal when mixed may be placed in a single container (refer to the MSDS to verify compatibility and consult with the Stockroom Manager if appropriate). As each quantity of chemical is added to the disposal container, the amount of the chemical and the date it is added should be recorded on an appropriate form attached to the disposal container. In teaching laboratories, it may not be necessary to record the amount of chemicals for disposal; check with the laboratory instructor and chemical Stockroom Manager for instructions.

Disposing of a Chemical Not Used in Its Entirety

If a chemical can be neutralized and/or deactivated to a non-hazardous product, the product should be poured down the drain with copious water. If a chemical to be disposed of is classified as hazardous, place it in a labeled waste container. The determination of "hazardous" versus "non-hazardous" is the responsibility of the laboratory supervisor, Stockroom Manager, and/or research supervisor. Under no circumstances should the determination be left to students. Refer to the Chemical Disposal section below.

Disposing of Containers after the Contents Have Been Discarded

Following the use of a chemical in its entirety, the empty container must be removed from the chemical inventory system.

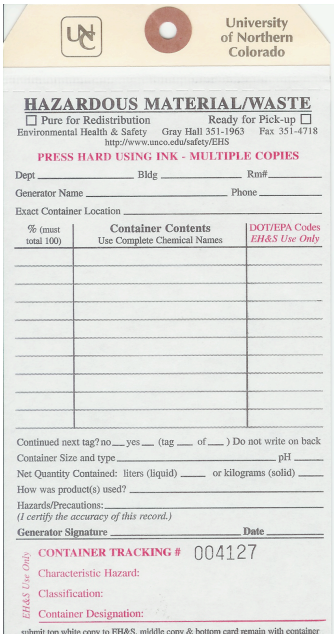
- remove the chemical inventory barcode from the container and take the barcode to the chemistry storeroom manager with information about the methods used for disposal of the contents and cleaning the container;
- rinse the container thoroughly with water;
- discard or wash the bottle for further use;

After washing the bottle completely and crossing out the label, it is discarded in the broken glass container without the lid. All labels must be removed if the bottle is to be reused. All students must refer any questions or concerns over the disposal and handling of the chemical bottles and labels to their research advisor.

Hazardous material disposal tags

Hazardous material must be collected in containers by type of chemical, noting amounts of chemicals added. Incompatible chemicals must not be put in the same container, see Figure 3. The EPA classifies chemicals for disposal in four categories: Ignitable, corrosive, reactive, and toxic.

A Hazardous Material/Waste tag must be completed (Fig. 4) for each container of material that is to be disposed. Tags can be obtained from the Stockroom Manager, and once full, the properly tagged disposal containers are delivered to the Stockroom. The tag must be affixed to a container as soon as it is full or no additional material is to be added to the container. The container, with affixed label, must then be taken to the Stockroom.


University of Northern Colorado

HAZARDOUS MATERIAL/WASTE

☐ Pure for Redistribution Ready for Pick-up ☐

Environmental Health & Safety Gray Hall 351-1963 Fax 351-4718
http://www.unco.edu/safety/EHS

PRESS HARD USING INK - MULTIPLE COPIES

Dept _____ Bldg _____ Rm# _____

Generator Name _____ Phone _____

Exact Container Location _____

% (must total 100)	Container Contents Use Complete Chemical Names	DOT/EPA Codes EH&S Use Only

Continued next tag? no ___ yes ___ (tag ___ of ___) Do not write on back

Container Size and type _____ pH ____

Net Quantity Contained: liters (liquid) ____ or kilograms (solid) ____

How was product(s) used? _____

Hazards/Precautions: _____

(I certify the accuracy of this record.)

Generator Signature _____ Date _____

CONTAINER TRACKING # 004127

Characteristic Hazard:

Classification:

Container Designation:

EH&S Use Only

submit top white copy to EH&S, middle copy & bottom card remain with container

Figure 4

The contents of the disposal container must be specifically identified along with the percent of their contribution to the volume of the total mixture for disposal. All chemicals present in the container must be identified; an additional tag may be attached if needed. The following information must be included in the appropriate place on the tag:

- the percentage of each chemical. If the total percentage of a chemical is less that 1%, write "trace" under the % column. If the contents of the container are unknown, indicate that.

- "Container Size and Type" (capacity of the container in kilograms if the chemical is a solid; indicate the volume in liters if the chemical is a liquid).
- pH of aqueous material
- quantity of chemical being disposed ("Net Quantity Contained" line);
- original use (whether the chemical was a reaction by-product, synthesis product, contaminated starting material, used for a wash, etc.)
- precautions to be taken with the chemical bottle (refer to MSDS);
- signature of generator and date.

Use and Disposal of Radioactive Materials

Inform the UNC Radiation Safety Officer (see contacts listing at the front of this guide) when radioactive materials are purchased and when they are ready for disposal. Handle according to appropriate procedures as indicated in the Appendix.

Use and Disposal of Biological Hazards

Contact the School of Biological Sciences for use and disposal procedures for biohazards. More information can be found in the Appendix.

Laboratory Ventilation

Laboratories should be well ventilated with sufficient airflow to allow fume hoods to function appropriately. All ducts, airfoils, and baffles should be clear during use. Conduct work inside the hood, at least 6 inches from the front airfoil. Only chemicals and equipment that are currently in use should be in a hood. Hoods are not to be used for long-term storage of chemicals or equipment; long-term storage of materials should follow guidelines in the previous section "Storage of Hazardous Materials".

Hoods will be tested regularly by Environmental Health and Safety for adequate airflow and tagged to show latest test. All hood malfunctions must be reported immediately to the Stockroom Manager, who will report it to campus Environmental Health and Safety.

Eyewashes and Showers

Eyewashes and showers must be activated weekly (ANSI 358.1-2004) to assure appropriate water flow and to clear the line of sediment and potential microbial buildup. UNC Facilities Management will conduct annual testing of valves and plumbing, and a tag showing the results of that testing should be attached to the equipment. The following rooms contain eyewashes and showers:

North Wing: Third floor, stockroom and teaching labs: 3615, 3635, 3650 (2), 3655, 3675, 3695. Third floor research labs: 3670, 3690; Second floor research labs: 2655, 2680, 2685; Basement: Chemical storage: 0254;
South Wing: Second floor teaching lab: 2280; Basement: Research lab: 0269

Chemical Spills and Fire

Dealing with spills: chemicals not spilled on person(s)

If a chemical spill occurs, it should be given immediate attention. All people working within the immediate area should be notified is a chemical spill occurs. If the accident occurs in a teaching laboratory, the laboratory instructor should be informed immediately. Students should not clean up a spill unless given direct consent and directions by the laboratory instructor. In research laboratories, the researcher should inform appropriate personnel of the spill. It is the responsibility of the supervisor of the researcher to determine the severity of the spill and inform the Stockroom Manager, CHO, and/or Department Chair of the incident (should it be deemed a severe spill), complete appropriate paperwork such as the accident report form as determined by the CHO, and insure that the spill has been properly addressed. The research supervisor, Stockroom Manager, or CHO will determine the need to contact EHS for cleanup of the spill.

Depending upon the potential hazard or severity of the chemical spilled, the room may need to be evacuated until the cleanup is finished; the MSDS should be consulted prior to using the chemical to determine if evacuation is required if a spill occurs.

Dealing with spills: chemicals spilled on person(s)

If a localized spill occurs on a person, the affected area should be washed with cool water for at least 15 minutes. If no burn or serve irritation is seen after rinsing the area with water for 15 minutes, the area should be washed with warm water and soap. All jewelry should be removed near the affected skin and cleaned before wearing it again. In all other cases the student should be directed to medical attention. The MSDS should be available to the first responders.

If an article of clothing has been contaminated by the spill, it should be removed immediately (see below). When removing clothing, especially shirts, it is important not to expose the eyes. Cutting off a shirt or other piece of clothing might be a safer course to avoid spreading the chemical.

Should clothing need to be removed due to the spill, and the affected area cannot be placed under the faucet of the sink, the person should immediately be moved to the safety shower. Once at the shower, the person will remove all clothing (whether contaminated or not) while running the water from the shower. Once the clothing has been removed, the person should remain under the shower for 15 minutes. If the safety shower is used, the chemical Stockroom Manager or other personnel should be notified. Due to the nature of such incidents, the Stockroom Manager, lab supervisor, or other personnel should immediately notify UNC police and/or call for an ambulance. Thus, the first responders (police or ambulance) will arrive as the person completes the 15 minutes in the shower. The first responders should also be notified of the details of the incident (specifics of the accident and treatment to date) to provide medical attention. A copy of the MSDS should be made available to the first responders.

The supervisor of the laboratory will provide directions on whether the article of clothing should be salvaged.

When chemicals are splashed in the eye, the eye should be flushed immediately at the eyewash station for 15 minutes, holding the eyes open so that the entire eye can be flushed with water. This action may require that another person hold the eye open. Contacts should be removed while flushing. The Stockroom Manager should be informed immediately of the incident and medical personnel contacted. The MSDS should be made available to the first responders.

Once the incident has been addressed and first responders notified, it the responsibility of the Stockroom Manager or lab supervisor, if the space where the incident occurred was not a teaching laboratory, to contact UNC police, Facilities, and EHS of the incident as part of the clean-up procedure.

Fires

Fire within the Department is a constant possibility. It is the responsibility of every member of the Department to be able to respond to a fire in an appropriate and timely manner. The most vital step that must be accomplished is the verifiable removal of all personnel from the building. The Department of Chemistry and Biochemistry has designated two areas outside of Ross Hall as places to gather in the event of such a building evacuation. Those areas, the lawn directly west of McKee Hall and the lawn directly south of Bishop-Lehr Hall, are the gathering points for evacuees from laboratories, offices, and other spaces on the 2nd and 3rd floor of the north wing of Ross Hall. Details of the evacuation plan in the event of a fire are attached in the Appendix to this document. Evacuation of the building is the first priority in the event of a fire.

All department personnel are required to inform their supervisees of this evacuation plan at the beginning of every semester. For example, the plan is announced every semester during the first Department Meeting of the faculty by the Chair; all Laboratory Coordinators will announce this to their Teaching Assistants at their first meeting of each semester; all Teaching Assistants will announce the evacuation plan to their students during the first meeting of each semester; etc. Adherence to this policy is vital to ensure that all personnel have the necessary information when a fire occurs. Following the plan is necessary in order to properly evacuate the building in the shortest time possible.

Fire Prevention

General housekeeping and safety-minded decisions may prevent fires from occurring. Some common fire preventative housekeeping measures include the following: making sure that all aisles and exits are clear, checking electrical cords before use, using open flames or pyrophoric chemicals appropriately, keeping combustibles, e.g., paper towels, away from hot surfaces and unneeded chemicals away from heat sources.

Types of Fire Extinguishers and Proper Usage

The National Safety Council has estimated that nearly all fires that occur in the United States are easily contained with a single fire extinguisher if the fire is caught soon after ignition. In many cases the fire can be extinguished quickly without the use of a fire extinguisher. Should one be needed, the information contained below is important to know. There are several types of extinguishers that can be used to fight small fires. (Fig. 5)

TYPE A extinguishers fight ordinary combustibles such as burning wood, cloth, paper, rubber, upholstery, and plastics

TYPE B extinguishers fight flammable liquids, gases and greases such as oils, paints, and gasoline.

TYPE C extinguishers fight energized electrical fires such as burning wires, circuit breakers, machinery, and appliances.

TYPE D extinguishers are used on fires involving combustible metals. These extinguishers are made for this specific type of material. (Adapted from http://ccfd6.org)

FIGURE 5

The typical fire extinguisher located throughout the building is an ABC extinguisher. These extinguishers are suitable for use on Type A, B, and C fires (see Figure 5). In addition to the ABC extinguishers, there are Type D fire extinguishers located in the organic teaching laboratory, the stockroom, and the chemical storage room.

If a fire is located around high field magnets, it is important to remain a minimum of 20 feet from the magnet, the extinguisher may be attracted by the magnetic field and result in a lethal projectile.

Following the discharge of an ABC extinguisher and the extinguishing of the flames, carefully sweep or vacuum the residue and wipe down all surfaces thoroughly. During clean up, the room should be ventilated to prevent respiratory irritation from the discharged material.

Fighting a fire with a fire extinguisher

It is easy to underestimate a fire. Only personnel trained in the use of a fire extinguisher are allowed to use them to fight the fire. If a fire extinguisher is used, it is important to remember to stand between the fire and the nearest escape. If a person has not been trained in the use of the fire extinguisher, he or she may attempt to extinguish the flames by another method (covering a flaming beaker with a larger beaker, moving a small beaker to the sink to douse the flames with water, etc.). Since even these methods require some training, it is necessary that all staff with supervisors be trained in extinguishing fires. Because the most important thing is to remove all personnel from danger, fighting the fire should be a secondary concern.

In the event of a fire in a laboratory, all equipment and any experiments should be turned off and the room evacuated immediately. One person from the laboratory should be sent to inform the Stockroom Manager of the accident and the actions that are being taken by the personnel in the laboratory. The Stockroom Manager then immediately calls campus police. The rest of the procedure for a building evacuation is then undertaken (see the Appendix).

Following are additional notes from *Safety in Academic Laboratories,* American Chemical Society, 7th ed, Vol 1 (Students), 2003, p34. For further information, see Vol 2 (Faculty and Administration, pp. 31-32.

- A fire contained in a small vessel can usually be suffocated by covering the vessel. For example, use a watch glass to suffocate a fire in a beaker by covering the mouth of the beaker. Do not pick up a vessel that is on fire. Do not cover it with dry towels or cloth; use a wetted material. Remove nearby flammable materials to avoid spread of fire.
- If the fire is burning over an area too large for the fire to be suffocated quickly and simply, all persons should evacuate the area except those trained and equipped to fight fires. Use the stairs to leave the building; do not use the elevators. Follow evacuation procedures that have been established and that have been practiced during prior fire drills.

Accident Reports

An accident report should be completed in the event of any accident or incident that causes injury or unwanted exposure to a chemical. In teaching laboratories, any accident, no matter how small, requires the completion of an accident report form. The completed form is to be filed with the Stockroom Manager, Laboratory Coordinator, Chemical Hygiene Officer, and the Chemistry department administrative assistant. The Safety Committee reviews all report forms periodically to determine if changes to operating procedures are needed.

Record Keeping

Records of exposures to hazardous chemicals that result in exposure assessments, medical consultations and medical examinations must be kept for 30 years. The OSHA Laboratory Standard (see below) recommends that documents related to employee training, significant employee suggestions, exposure complaints and suspected exposures (whatever the outcome), complaints from employees (or graduate students), and investigation outcomes be documented for future reference.

Training Program

The mandatory annual training program is to be attended by graduate students, researchers, and faculty in the department. Record of attendees will be generated by those performing the training and kept on file within the main office with the training documents for that year for 30 years (see above). Personnel that do not attend the annual training will be notified by the main office of their failure to comply by the first day of the Fall semester. Those personnel who have not attended training will not be allowed to enter any laboratory within the department (teaching or research) for ANY purpose. The Chair of the Department will note any failure to comply in all annual/biennial and comprehensive reviews for faculty. This could affect the ability of a graduate student or faculty researcher to receive an assistantship, pay, or employment.

Undergraduate students in undergraduate laboratories will participate in safety training as part of the first laboratory of each semester. The training requirements for each group are different, and training is customized to address issues each group faces. All students, whether they join the lab course at the start of the semester or are a late admission, MUST receive the safety training. Records are to be kept of all students and the specific training each received for 30 years. In all cases, the specific training will address the requirements of the OSHA Laboratory Standard. (See below.)

The OSHA Laboratory Standard

The following comes from *Safety in Academic Chemistry Laboratories*, vol. 2 (Accident Prevention for Faculty and Administration), 7th Ed., American Chemical Society, 2003.

In January 1990, OSHA published the final rule, Occupational Exposures to Hazardous Chemicals in Laboratories, better known as the "Laboratory Standard." (29 CFR 1910.1450) This rule recognizes that the exposure potential for laboratory-scale work with hazardous materials may be different from exposures in the industrial sector. The information contained therein should be included, as necessary, in all training sessions.

Standard Operating Procedures (SOPs)

The guidelines of this document focus on the standard operating procedures for the teaching laboratories, with emphasis on the general chemistry laboratory. Should a teaching laboratory require SOPs beyond what is recorded in this document, the laboratory coordinator for the specific laboratory should complete a separate document on the safety requirements of that laboratory. Moreover, standard operating procedures should be prepared for ALL research laboratories by the supervisor of that laboratory, whether those procedures differ from this document or not.

All SOPs should include procedures for handling every hazardous chemical as part of any experiment performed in the laboratory. The SOP documents should also contain safety procedures for the use of instrumentation, disposal of unwanted materials, and other hazards common to the specific laboratory. The SOP should then be used to train all personnel using the specified laboratory or conducting the specified experiments in another laboratory. The training of all researchers and teaching assistants is the responsibility of the supervisor of that laboratory.

The SOP for each laboratory should be prepared in triplicate and stored so that anyone has easy access. The copies of the SOP should be kept in (a) the laboratory in question, (b) the office of the laboratory supervisor, and (c) the department main office. Any SOP beyond this document should be consistent with OSHA intent and the department-approved CHP. For help in creating a laboratory-specific SOP, see Young, Kingsley, and Wahl, *Developing a Chemical Hygiene Plan.*

Resources

American National Standards Institute (ANSI), Standards Z87.1-2003 (Occupational and Educational Personal Eye and Face Protection Devices) and Z358.1-2004 (Emergency Eyewash and Shower Equipment).

Flinn Chemical and Biological Catalog, Flinn Scientific Inc. www.flinnsci.com

National Research Council, *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals,* National Academy Press, Washington, D.C., 2011.

National Fire Protection Association (NFPA), Standard 45 (Fire Protection for Laboratories Using Chemicals, 2004)

Occupational Safety and Health Administration (OSHA), Occupational Exposure to Hazardous Chemicals in Laboratories, the "Lab Standard," CFR 1910.1450

OSHA Hazard Communication Standard, CFR 1910.1200

Safety Audit/Inspection Manual. American Chemical Society, 2000.

Safety in Academic Laboratories. American Chemical Society, 7th ed. vols 1 (student) and 2 (faculty), 2003. (One copy of each vol FREE—call 800-227-5558.)

Young, Kingsley, Wahl. *Developing a Chemical Hygiene Plan.* American Chemical Society, 1990.

Appendix 1 – Biohazardous Materials and Radioactive Materials

Biohazardous Materials

For even the most experienced laboratory personal, careful review of the 2009 publication *Biosafety in Microbiological and Biochemical Laboratories* (BMBL; HHS/CDC/NIH, 2009) should be a prerequisite for beginning any laboratory activity involving a microorganism, weather naturally or synthetically derived. It defines four levels of control that are appropriate for safe laboratory work with microorganisms that present occupational and public health risks, ranging from no risk of disease for normal healthy adults to high risk of life- threatening disease. The BMBL provides guidance for handling specific agents and a tiered approach to control and containment for each biosafety level.

The four levels of control, referred to as biosafety levels (BSL's) 1 through 4, describe microbiological practices, safety equipment, and features of laboratory facilities for the corresponding level of risk associated handling a particular agent. The designation of a BSL is influenced by several characteristics of the infectious agent, the most important of which are the severity of the disease, the mode and efficiency of transmission of the infectious agent. The availability of protective immunization or effective therapy, and the relative risk of exposure created by manipulations used in handling the agent, Novel synthetic agents should be handled at a higher BSL until the characteristics of the agent are better understood. Biological toxins are generally safely handled using BSL 2 practices and procedures with a strict attentions to sharps safety, PPE, and the appropriate use of containment equipment. Certain agents and toxins designated as select agents under 42 CFR Part 73 have security requirements that must be met in addition to the biosafety requirements addressed through the application of BSL.

BSL 1 is the basic level of protection appropriate only for agents that are not known to cause disease in normal healthy adult humans.

BSL 2 is appropriate for handling a broad spectrum of moderate- risk agents that cause human disease by ingestion of through percutaneous or mucous membrane exposure. Hepatitis B virus, salmonellae, *toxoplasma* spp., and human blood and body fluids are representative BSL 2 agents. Extreme precaution with needles or sharp instruments is emphasized at this level.

BSL 3 is appropriate for agents with potential for respiratory transmission, agents that may cause serious and potentially lethal infections, and agents that have a moderate risk to the outside community as wells as that individual. Emphasis is placed on the control of aerosols by performing all manipulations within a biological safety cabinet or other containment equipment. At this level, the facility is at least two doors from general building traffic, has a dedicated exhaust fan designed to operate the facility under a negative pressure gradient, and usually is equipped with HEPA filters to purify the air before it is exhausted to the outside. Air from these laboratories cannot be recirculated to other areas of the building. These requirements are designed to control the access to the laboratory and to minimize the release of infectious aerosols from the laboratory. The bacterium *Mycobacterium tuberculosis* is an example of an agent for which this higher level of control is appropriate.

Exotic agents that pose a high individual risk of life-threatening disease by the aerosol route and for which no treatment is available are restricted to high containment laboratories that meet BSL 4 standards. These agents represent a higher risk to the community because of their higher morbidity and mortality rates. Protection for personnel in these laboratories includes physically sealed gloveboxes or fully enclosed barrier suits that supply breathing air.

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[1] *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards.* National Research Council: The National Academies Press, Washington D.C., 2011, pp. 126 – 127.

Several authoritative reference works are available that provide excellent guidance for the safe handling of infectious microorganisms in the laboratory, including BMBL (HHS/CDC/NIH, 2009), the *NIH Guidelines for Research Involving Recombinant DNA Molecules* (NIH, 2011) and *Biosafety in the Laboratory –Prudent Practices for the Handling and Disposal of Infectious Materials* (NRC, 1989).Standard microbiological practices described in these references are consistent with the prudent practices uses for the safe handling of chemicals. *Biosafety in the Laboratory* lists seven foundational work practices in biosafety:

1. Do not eat, drink, or smoke in the laboratory. Do not store food in the laboratory. Keep your hands away from your face; avoid touching your eyes, nose, or mouth with gloved hands.
2. Do not pipette liquids by mouth; use mechanical pipetting devices.
3. Wear personal protective clothing in the laboratory (e.g., eye protection, laboratory coats, gloves, and face protection).
4. Eliminate or work very carefully, with sharp objects (such as needles, scalpels, Pasteur pipettes, and capillary tubes).
5. Work carefully to minimize the potential for aerosol formation. Confine aerosols as close as possible to their source of generation (i.e., use a biosafety cabinet).
6. Disinfect work surfaces and equipment after use.
7. Wash your hands after removing protective clothing, after contact with contaminated materials, and before leaving the laboratory.

Other practices that are most helpful for preventing laboratory= acquired infections or intoxications are as follows:

- Keep laboratory doors closed when experiments are in progress.
- Use leek proof secondary containment to move or transfer cultures.
- Deactivate, disinfect, or sterilize infectious waste before disposal.

Radioactive Materials

The receipt, possession, use, transfer, and disposal of the most radioactive materials is strictly regulated by the U.S. Nuclear Regulatory Commission (USNRC) (see 10 CFR Part 20, Standards for Protection against Radiation) and by state agencies who have agreements with the USNRC to regulate the users within their own states. Radioactive materials may only be used for purposes specifically described in licenses issued by these agencies. Individuals working with radioactive materials need to be aware of the restrictions and requirements of these licenses. Consult your institution's radiation safety officer or other designated EHS expert for training, policies, and procedures specific to uses at your institution. Prudent practices for working with radioactive materials are similar to those needed to reduce the risk of exposure to toxic chemicals (section 6.C has similar information) and to biohazards:

- Know the characteristics of the radioisotopes that are being used, including half-life, type and energy of emitted radiation, potential for and routes of exposure, and annual exposure limit. Know how to detect contamination.
- Protect against exposure to airborne and ingestible radioactive materials.
- Never eat, drink, smoke, handle contact lenses, apply cosmetics, or take or apply medicine in the laboratory. Keep food, drinks cosmetics, and tobacco products out of the laboratory entirely to avoid contamination.

- Do not pipet by mouth.
- Provide for safe disposal of waste radio nuclides and their solutions.
- Use PPE (e.g., eye protection, gloves, protective clothing, respirators) to minimize exposures.
- Use shielding and gloveboxes to minimize exposure.
- Use PPE (e.g., eye protection, gloves, protective clothing, respirators) to minimize exposures.
- If possible, use equipment that can be operated remotely.
- Plan experiments to minimize exposure by reducing the time, using shielding, increasing your distance from the radiation, and paying attention to monitoring and decontamination.
- Keep an accurate inventory of radioisotopes.
- Record all receipts, transfers, and disposals of radioisotopes.
- Record surveys.
- Check personal and the work area each day that radioisotopes are used.
- Plan procedures to use the smallest amount of radioisotopes possible.
- Check waste materials for contamination before discarding.
- Place only materials with known or suspected radioactive contamination in appropriate radioactive waste containers.
- Do not generate multihazardous waste (combinations of radioactive, biological, and chemical waste) without first consulting with the designated radiation and chemical safety officers.

Appendix 2 – Fire Evacuation

Department of Chemistry and Biochemistry
Emergency Plans for Fire Evacuation

The following steps will ensure the rapid evacuation of the spaces under control of the Department of Chemistry and Biochemistry in the event of a fire or other emergency requiring evacuation. This evacuation plan requires that all faculty and staff know the steps involved in the plan and that all steps are followed properly.

Step 1: Fire Alarm Sounds

As soon as a fire alarm sounds in the building, all teaching assistants and researchers should begin taking steps to evacuate their laboratory spaces. All students in the labs should be told to unplug hotplates, Variacs, and other electric heating sources and extinguish all flames. All other experimental operations should be terminated as quickly as possible, inasmuch as is possible to do so without creating additional hazards.

It is the responsibility of the TAs, faculty member, or research students to ensure that their labs and lecture halls are evacuated as quickly as possible. A headcount, or role, of any students as they leave the laboratory or lecture hall should be taken.

If the fire is observed in a teaching or research laboratory, the TA or researcher should immediately send a student to the Stockroom or Main Office. That student should inform personnel at that location that a fire has occurred and the steps that are being taken to date by the TA or researcher. Should a TA or researcher elect to fight the fire (the TA or researcher MUST BE TRAINED in the use of a fire extinguisher in order to do so), a second student is appointed to act as the TA for the remainder of the evacuation.

Step 2: Evacuate Building

The TA, faculty member, researcher, or their designee, should then follow any students under their care to the appropriate gathering areas. Those areas are designated below:

STARTING BUILDING LOCATION	**GATHERING AREA**
ROSS Chemistry floors east end (room number > XX49)	Bishop-Lehr South Lawn
ROSS Chemistry floors west end (room number < XX49)	McKee Hall West Lawn
Lecture Halls/Laboratories elsewhere in ROSS	Evacuate Building by nearest exit Proceed to a lawn area at least 300 ft from building. Send runner to McKee Hall West Lawn if the evacuation count shows missing people

Once the TA, faculty member, researcher, or designee has arrived at the gathering location, they are to retake the headcount or role to verify that all personnel under their care arrived at the location. Should the count differ, that information should be disseminated to at least one faculty member from Chemistry and Biochemistry at that location.

Step 3: Verify Headcount and Remain in Location

The Fire Wardens, see below, will collect headcount information and should a missing student, faculty member, or researcher be identified, they will inform fire fighting personnel as quickly as possible.

For those groups gathering in other locations (lecture halls outside of 2nd and 3rd floor Ross Hall), all students and instructors should remain in that location. The exception to the "remain in place until dismissed" rule is that the instructor should send a student to the McKee Hall West Lawn gathering place to inform a Fire Warden if there is a discrepancy in the headcount.

All personnel should remain in the gathering location until dismissed by their immediate supervisor. For example, classroom or laboratory students are only dismissed by their instructor; faculty, staff and graduate students are only dismissed by the Chair of the Department. The fire alarm may be a false alarm, at which point classes or laboratories could be resumed.

Step 4: Cleanup

After the call has been completed (false alarm or actual fire extinguished) and the building is cleared for occupancy, all laboratory instructors whose labs were interrupted and all researchers whose experiments were interrupted are to immediately return to the laboratory to clean up the unfinished experiments. If students have been dismissed, it is the responsibility of the TA to clean the laboratory and return it to operating conditions.

Fire Warden Responsibilities

At the start of a fire alarm, one person from the Main Office and one person from the Stockroom are immediately designated as Fire Wardens. Should the stockroom be closed (outside of normal Stockroom hours), the Main Office Fire Warden will appoint a second Fire Warden to conduct the duties of the Stockroom. Should the Main Office not be staffed at the time of the fire alarm, the Stockroom Fire Warden will appoint a second Fire Warden to conduct the duties of the Main Office Fire Warden.

The Fire Wardens are charged with the responsibility of ensuring that all rooms under their care are evacuated. The Fire Wardens should the last people exiting the building. Once at the designated gathering spaces, the Fire Wardens should gather the missing headcount numbers (should any students be missing) and report that information to the fire fighting personnel as quickly as possible. Should both locations be unstaffed, the duties of the Fire Warden fall to any faculty and graduate students present in the Department at the time of the alarm.

The Stockroom Fire Warden will move quickly to the elevators to meet the Main Office Fire Warden. Then, after meeting, they will each proceed down the hallways (3600 hallway for the Stockroom Fire Warden and 3500 hallway for the Main Office Fire Warden), verifying that each room has been evacuated before proceeding to the next room. The two Fire Wardens will then move down the stairs and repeat the task on the second floor. The Main Office Fire Warden, after checking Chemistry and Biochemistry faculty offices on second floor will then exit the building and proceed to the Bishop-Lehr South Lawn. The Stockroom Fire Warden, after checking labs on second floor, will exist the building and move to the McKee Hall West Lawn.

Once at the gathering places, the Fire Wardens will gather any information about missing personnel and report that to the fire fighting personnel at the earliest opportunity.

Appendix 3 – Tornado Warning Emergency Plan

Department of Chemistry and Biochemistry
Emergency Plans for Tornado Threat

The following steps will ensure the rapid movement of the areas under control of the Department of Chemistry & Biochemistry in the event of a Tornado Warning. This plan requires that all faculty and staff know the steps involved in the plan and that all steps are followed properly.

Step 1: Announcement of a Tornado Watch
In the event of a Tornado Watch, the main office staff and the stockroom personnel shall be notified. It is their responsibility to stay in contact with the weather information.

Step 2: Tornado Warning is given through the UNC Alert System
As soon as a tornado warning is issued for the area, all teaching assistants, researchers, and instructors should begin taking steps to evacuate the laboratory, office, and research spaces. All students in the labs should be told to unplug hotplates, variacs, and other electric heating sources.

A designated member of the Stockroom personnel will immediately walk to the elevators to meet a similarly designated member of the Main Office. A second member of the stockroom or main office will take the elevator to the basement to open the stairwell door for everyone to be admitted via the west stairwell. The other two designated members will each perform a walkthrough of the two hallways and meet at the East stairwell. During the walkthrough, any people found will be instructed to proceed directly to the basement.

Once at the East stairwell, the two designated members will repeat the walkthrough on the two hallways on second floor, again meeting at the West Stairwell. Both will then proceed directly to the basement. Their arrival will signal that the stairwell door can be closed.

Step 3: It is the responsibility of the TA's, faculty members, or research students to ensure that their labs and lecture halls are evacuated as quickly as possible. A headcount, or role, of any students as they leave the laboratory or lecture hall should be taken. In any case, the labs MUST be evacuated as the designated member from the Main Office or Stockroom approaches.

Step 4: All personnel are then directed to the west stairwell with the responsible person following. Once in the basement area, the responsible person should retake the headcount to verify that everyone in their care arrived at the specified location. Should the count differ, that information should be disseminated to one of the members of the staff from the Main Office. All personnel will remain in the basement until campus security or the UNC alert system notifies them that it is safe to leave the basement area.

Step 5: After the alarm has finished, all personnel are allowed to return to their laboratory or other areas. Any labs that were interrupted should be returned to immediately so that the instructor and students can clean up or finish the experiment as necessary. It is the instructor's responsibility to make sure that the lab is cleaned and returned to normal operating conditions. Only after the lab has reached normal conditions can students be dismissed.

Appendix 4 – Active-Shooter/Intruder Lockdown Procedures

Department of Chemistry and Biochemistry
Emergency Plans for Secure-in-Place

The following steps will ensure minimum danger in the event of an active shooter or harmful intruder on campus. This plan requires that all faculty and staff know the steps involved in the plan and that all steps are followed properly and quickly.

Step 1: Announcement of Active-Shooter/Intruder
In the event of a harmful intruder of any kind, all phones in the building will report an emergency action message. For those in range of the phone, a PA speaker will announce the threat. For those rooms that do not have phones (as of July 2014, the teaching laboratories do not have phones), the announcement may be heard on a cell phone. It is the instructor's responsibility in those teaching labs without a phone to have their personal cell phone with them in order to receive an announcement.

In the 2014-15 academic year, the Department will finish installation of phones in each space within the Department. Do NOT assume a room has a phone until it is announced from the Main Office.

Step 2: Lock in place
As soon as the warning is issued, all teaching assistants, researchers, and instructors should begin taking steps to "lock in place". Do NOT delay this action, even for a minute.

If in a teaching laboratory, the instructor should have the students turn off all equipment as quickly as possible (pulling the plug out of the socket often works). Then, all students should be moved under the blackboard/white board and told to take a seat on the floor. The lights should be turned off in the room and the doors locked (if they are not already locked). The instructor should occupy a position on the floor close to the wired phone in the room in order to receive or provide communication if needed.

If in a research laboratory or office, the occupants should ensure the doors are locked, the lights turned off, and then find a seat on the floor where they cannot be seen from the doors.

All occupants of the rooms should remain quiet (not even whispers) until the threat has passed. Use of cellphones should be strongly discouraged as the lights from a cellphone may illuminate the room.

Step 3: It is the responsibility of the TA's, faculty members, or research students to ensure that the students under their charge follow the rules and remain quiet and still during the event.

Step 4: When the event has passed, the "all-clear" announcement will be made via the phone. Under no circumstances should the door be opened, the lights turned on, or etc until the "all-clear" is announced. Do NOT respond to a knock at the door, to someone in the hall saying the event has passed, or any other attempts to communicate across the door.

In some cases, the "all-clear" announcement may not be made to the phone. In these instances, either the Administrative Assistant or the Chair of the Department will unlock the door to the room and announce the "all-clear".

Step 5: At the end of the event, the students or researchers should return to the experiment in progress. The instructor should announce whether the experiment will be finished or cleaned up.