Safety and Chemical Hygiene Plan
Department of Chemistry, University of Nebraska-Lincoln
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The Department Safety Committee, which is described within section 10 (*Administrative Controls*), maintains and updates this plan. The Safety Committee Chair and Chemical Hygiene Officer for 2016-17 is Prof. Pat Dussault (402-472-6951, pdussault1@unl.edu). The co-Chair is Prof. Martha Morton (402-472-6255; mmorton4@unl.edu)

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1 Overview

1.1 Administrative Controls.

The responsibilities of students, researchers, teaching assistants, professional staff, facility directors, faculty investigators/PIs, safety committee members, and departmental leadership are described in section 10.

1.2 Hazard Assessment (overview)

As you read through this document or plan an experiment, think in terms of *Hazard/Risk assessment*: Evaluate hazards, methods of mitigation, and possible emergency situations before you begin an experiment or activity.

- What are you planning to do? Think of all steps and processes.
- What are the associated hazards of the reagents, equipment, and byproducts?
- What could possibly go wrong?
- Are there changes in procedure (scale, process) that would reduce the chances of an accident or, if an accident occurs, minimize the chances of damage or injury?
- What engineering controls (hoods, for example) would minimize the chances of accidents or injuries?
- What personal protective equipment is needed?
- What emergency equipment and procedures will you use if an accident does occur? (first aid, spill kits, etc.).

1.2.1 Hazard Assessment Resources:

Identifying and Evaluating Hazards in Research Laboratories (ACS Committee on Chemical Safety, 2015; in particular, the "Job Hazard" or "What if analysis" sections. See: http://www.acs.org/content/acs/en/about/governance/committees/chemicalsafety.html (under "Safety Practices and Recommendations")

Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, Updated Version (National Academy Press, 2011). Free download available at: http://www.nap.edu/download.php?record_id=12654

*Safety in Academic Chemistry Laboratories: Volume 1 (*student edition, college);
Safety in Academic Chemistry Laboratories: Volume 2 (instructor edition)
Safety for Introductory Chemistry Students Brochure
Available from ACS Committee on Chemical Safety (under "Classroom Safety")
http://www.acs.org/content/acs/en/about/governance/committees/chemicalsafety.html

Assessment of chemical hazards is discussed in section 6.

1.3 Emergency-related Equipment and Procedures

- Summon help by dialing 911, 402-472-2222 (**2-2222** from a campus phone), or by picking up a **Red** emergency telephone (located at the corridor junctions on floors 2-8 and Basement, and near the south door of the 1st floor).
- Fire alarms are near each stairwell entrance on Hamilton 2-8, near each exterior door on 1st floor, and at the north end of the basement.
- Laboratories in Hamilton Hall are equipped with CO_2 (carbon dioxide) fire extinguishers; in some cases, dry chemical (powder) extinguishers are also present.
- The 9th floor of Hamilton contains facilities intended for special operations. Contact the Safety Committee Chair before use. *Note: There is no emergency phone on the 9th floor.*
- Eyewash fountains are present in laboratories or as eyewash hoses outside a lab door. *You must know how to find the nearest eyewash without looking!*
- Safety showers are present at the entrance to most laboratories. *You must know how to find the nearest shower without looking.*
- Chemical operations are normally performed in fume hoods.
- Hazardous materials may only be used in appropriate (laboratory) settings.
- Secondary containment must be employed for transport of chemicals outside of labs.
- Use of devices for breathing protection (masks, respirators) requires training and approval by Environmental Health and Safety (EHS).
- Radioactive materials may only be used in approved sites after special training and approval from UNL Radiation Safety (see below).
- Accidents and " near misses" must be reported. See Section 2.8.
- "Experimenters are ultimately responsible for complying with Federal, State, and University requirements for purchase, transport, and appropriate use of chemical and biological reagents. (See sections 6 and 10)

1.4 Alarms / Warnings

1.4.1 Fire

Voice notification, plus sound, plus blue flashing light.

- Exit the building immediately via the nearest stairwell. Close and lock laboratory or office doors as you leave. Turn off the power to experiments and take your belongings (i.e. coat, backpack, etc. only if you can do this in just a few seconds.
- If your first exit route is blocked, try an alternate route; remember that there are stairs at the end of each hall. Do not try to use the elevators. When the fire alarm sounds, the elevators will descend to the first floor, and remain there.
- Once you get outside, move away from the building. Members of individual labs/offices/facilities should assemble in the Sheldon parking lot to make sure everyone has gotten out. If you believe an unattended experiment may pose a safety problem, or if there is concern that someone failed to get out of the building, notify emergency officials.
- If you have information about the emergency, notify emergency officials, tell them what you know, and remain with them until released.
- Do not try to reenter until the police or firefighters give an “all clear” signal.

1.4.2 Tornado

Voice notification plus flashing light (also via UNL Alert)

- STAY INSIDE. Go to the BASEMENT or to the NORTH hallway on floors 2, 3, 4, or 5.
- The elevators WILL work and may be used. However, you should give up space for individuals who would have trouble using the stairs. Avoid the first floor lobby (windows) and the large lecture rooms (already crowded).
- STAY AWAY FROM EXTERIOR WINDOWS. The tornado will shatter windows and create flying glass shards that are very dangerous.
- The City of Lincoln tornado alarm may sound before the campus tornado alarm. Seek shelter immediately whether you hear the city alarm or the UNL alarm.
- The UNLAlert system will not issue an "all clear" for tornadoes. Use a smart phone to check a weather site (e.g. National Weather Service) or local media to determine when it is safe to go return to offices and labs.

1.4.3 Dangerous Chemical Spill

Fire Alarm, buzzer, loudspeaker announcement, or coworkers yelling:

Exit the building as rapidly as possible. Take your belongings (i.e. coat, backpack, etc. only if you can do this in just a few seconds. Use the stairs if possible.

Do not attempt to return to your lab or office; you have no way of knowing where you could encounter the hazardous material.

If you find your way blocked by a spill or noxious fumes, find an alternate route. Section 2.2 provides more detail about chemical spills.

1.4.4 UNL Alert.

UNL Alert is a mass notification system providing real time alerts to your phone, computer and/or mobile device over situations ranging from gas leaks to flash flood watches to reports of a threatening person. Everyone is encouraged to sign up: unlalert.unl.edu.

2 Emergency Situations

You need to be prepared for any of the situations described in this section. Procedures for reporting injuries re described in Section 2.8.

In general, emergencies should be reported to 911, 402-472-2222 (2-2222, using the Red emergency phones).

2.1 FIRE or EXPLOSION

2.1.1 MAJOR FIRE

A "major" fire is simply dangerous: It may have spread beyond a small area; be burning in a poorly ventilated area; be emitting toxic fumes; have the potential for rapid expansion (for example, a fire around solvent bottles). In short, a major fire is one that places you in danger of major injury or death. Your only responsibility is to escape and sound the alarm.

- YELL to alert others in your area.
- LEAVE. Close the door(s) behind you. Pull the **Red** fire alarm at any corner of Hamilton Hall and go down the stairs. Exit the building.
- From a safe location, call 911 or 402-472-2222. STAY ON THE LINE UNTIL SOMEONE ANSWERS. Tell the operator the location of the fire and any other important facts (was anyone injured; do you know the chemicals involved, etc.)
- Treat any significant EXPLOSION (causes injury and/or a fire and/or results in major structural damage) as a major fire. Call for help, be prepared to help others (first aid, summoning medical assistance) and evacuate the area.

2.1.2 SMALL FIRES

A small fire is defined as follows:

- There is no immediate danger of the fire rapidly expanding.
- You are not alone and you have a safe path of retreat.
- You know enough to be confident that you are not exposed to toxic fumes.

Have someone pull the fire alarm;

- Use a fire extinguisher (See section 3.1 ("Fire Extinguishers") to extinguish the fire.
- Stay nearby to make sure the fire does not reignite and wait for the fire department to arrive and check the situation.
- *If you cannot put out a fire with a single extinguisher,* ***get out!***

2.2 CHEMICAL SPILL

Resource: *PrePlanning and Responding to Chemical Spills (EHS).*(http://ehs.unl.edu/sop/s-preplan_respond_spills.pdf)

2.2.1 Major Chemical Spill:

A MAJOR spill is defined as:

- Any spill of flammable, toxic, or corrosive liquids in a public area (hallway, elevator) or a poorly ventilated space (e.g. office). *Hazardous materials may never be brought into office areas and must be placed in secondary containment (bucket, plastic bin) for transport through public areas (hallways, elevator).*
- Any spill or release of a material that could produce death or serious injury upon short exposure (for example, GHS inhalation toxicity hazard of 1 or 2).
- > 1 gallon ≈ 4 liters of any flammable or corrosive liquid, *anywhere.*

What should you do?

- YELL to alert others and to get help with notifications and "blocking".
- Close the doors to the lab or affected area to prevent spread of the spill.

- IMMEDIATELY pull the **Red** building alarm located near the “T” of Hamilton Hall.; this will evacuate the building.
- For a spill in an open area (e.g., hallway), quickly “block” off the area with chairs or lab stools or similar if you can do this without exposing yourself to danger.
- From a safe location, call 402-472-2222 or use the **Red** emergency telephones. STAY ON THE LINE UNTIL SOMEONE ANSWERS. Tell the operator the location of the chemical spill and the nature of the spill.
- If you are the expert on the spill, identify yourself to the Safety Committee Chair or one of the first-responders.

2.2.2 MINOR SPILL.

A chemical spill is MINOR when:

- You are in no danger (you are not alone, the area is well-ventilated, and you are certain you are not in danger of exposure to highly toxic materials).
- The spill involves a relatively small amount of material (less than 4L of solvent or corrosive reagents), you are familiar with the material, and you are confident you can clean it up safely.
- Your lab or facility has an appropriate PPE and a spill kit capable of cleaning up the spill (see below)
- Any doubts? call EHS (402-472-4025, daytime) or 402-472-2222 (after hours) and report a "chemical spill."

Wear protective gloves, eye protection, and a lab coat. If in doubt what to do, consult the Safety Chair or another member of the committee, or call EHS (402-472-4925). All labs must have appropriate absorbent materials or commercial spill kits available.

- Build a “dam” of absorbent material around the spill.
- Add additional absorbent to soak up the bulk of the spilled chemical.
- Using a brush, rake the absorbent into dustpan, and empty the dustpan into a plastic bucket or a plastic bag with a "zip" type closure. Each lab should have this equipment. Any other materials contaminated during the cleanup should also be added to the plastic bag or bucket.
- Store the bucket or bag and contents (appropriately labeled "Spill sorbent plus recovered [full name]" EH&S can come over to pick them up. (402-47**2-4925**).

2.2.3 Mercury spills:

Labs should minimize use of mercury-containing devices. Whenever possible, use alcohol or digital thermometers, and digital vacuum gauges. If equipment with mercury must be used, the apparatus or storage device containing the mercury should be contained within or over a trough, sand pit, or similar container capable of capturing mercury in the event of breakage.

- Broken mercury-containing apparatus should be placed in a zip-loc bag for pickup by EH&S. Block off the area with chairs, waste cans or other objects so that others do not track through the area and spread the mercury further. Close the doors and leave.
- Contact EH&S (2-4925). They will come over and take care of the spill.

2.3 Injury Accident or Medical Emergency

Injury procedures: ON-THE-JOB AND STUDENT INJURIES (EHS, revised 10/16) (https://ehs.unl.edu/sop/s-injury.pdf; Also, UNL Chemistry Safety: http://chem.unl.edu/safety - injury

First aid kits: http://ehs.unl.edu/sop/s-firstaidkit.pdf

- Yell! Get others involved!
- Before approaching the injured person, look for hazards. Is there an electrocution hazard, or an inhalation hazard with a toxic chemical? Do you need to pull on gloves?
- If the victim is on fire, get them under a safety shower ASAP. Don't worry about clothes or dignity; you need to extinguish the fire. Keep the burned area under the shower for several minutes.
- If the victim has suffered a major chemical exposure, get them under a safety shower ASAP. This is not the time to think about dignity; get contaminated clothes off and rinse the chemical off the skin. Rinse for fifteen minutes if the person's condition will allow.
- Someone should dial 911 or 402-472-2222 or use the **Red** emergency phones. *Remember-no help can come until someone calls in the emergency*. Inform the operator of the location and nature of the emergency. Example: "John Smith has been badly burned with sulfuric acid. He is under a safety shower outside room 1212. My name is Jane Jones".
- If you are the only one who can help, leave the phone/connection open or put your cell phone on "speaker" while you provide assistance.
- Provide whatever assistance you can as long as you can remain safe. You may need to apply a bandage or compression to limit bleeding. However, particularly for burns, do not attempt to apply any creams or medicines; leave this to the emergency responders.
- If blood or bodily fluids are in evidence, pull on disposable gloves.
- If the person is not breathing and you cannot detect a pulse, start chest compressions.

2.3.1 Procedures for chemical exposure

If you spill a chemical on yourself or others, YELL FOR HELP and REMOVE THE CHEMICAL IMMEDIATELY. Except for the rare case of water-reactive metals (sodium, potassium), the best first step is to flush the affected area with large amounts of water.

- For an arm or hand, use a sink. Rinse for several minutes, not just for a few seconds. For a "whole-body" spill, use the safety shower located just inside or outside a door in most Hamilton labs. Remove contaminated clothes-this is not the time to be modest.
- For eye contamination, use the Eye Washes located in almost every lab (use the sink if you cannot find an eye wash). Hold the eyelids open and wash for at ten (10) minutes. See section 3.4
- For active metals (potassium, sodium) or metal hydrides ($LiAlH_4$), remove the affected clothing or brush the metal off before putting anyone under the shower.
- While you are removing the chemical, someone needs to call 911 or 402-472-2222 or use the **Red** emergency phones. Inform the operator of the location of the victim and the nature of the emergency: "John Jones has spilled sulfuric acid down his leg; he is in Hamilton 218."
- If you are the only one who can help, leave the phone/connection open or put your cell phone on "speaker". Remember-no help can come until someone calls in the emergency.
- Ask someone to print out a Safety Data Sheet (SDS or MSDS) for the chemical) and have this ready for the emergency responders.
- Do not try to apply any creams or offer any medicines; leave this to the emergency responders.
- Know the location of the safety shower before an emergency occurs.

2.3.2 Flood

- Check for electrical hazards (an electrical cord or appliance in the water) before entering the space. If you are unsure, STAY OUT and call for help.
- If you can safely enter the space, TURN OFF THE WATER. Daytime: Call the Building Manager (402-472-5312) or the Facilities Hotline (402-472-1550). After hours, call 402-47**2-2222** or use the **Red** phone.
- Prevention is the watchword. Do your utmost to make sure that tubing is secured, and will not separate from the apparatus or "leap out" of the drain when the pressure surges. Rubber or plastic tubing must be secured to hose connectors ("nipples") using special tubing clamps that prevent the tubing from slipping off the hose connectors. Tubing can be secured into a drain using a three-finger clamp.
- Simple "water flow" monitors can be used to ensure that the flow of water is not too large, leading to the difficulties directly above.

2.4 Gas Leaks:

2.4.1 STRONG odor of natural gas.

- Yell to alert others!
- Extinguish any flames and close off any gas valves if you can do so without delaying your departure.
- LEAVE the area and <u>close the lab doors</u>.
- Actuate the fire alarm and dial 402-47**2-2222** from another floor or another building
- Certain sulfur compounds produce the same odor as natural gas. When you alert others to the danger of natural gas, inquire to see if anybody is using "thiols". If "thiols" are in use, there may be no actual gas leak.

2.4.2 WEAK natural gas odor

If you smell a weak gas odor and determine that other researchers are NOT using "thiols" (see above), check that natural gas valves in the room are completely closed. If this does not correct the problem, contact the building manager or safety chair. He/she will arrange for an inspection by EH&S or the gas company. If the minor gas leak is in a fume hood, close the fume hood sash. If the minor gas leak is from the benches, open up fume hood sashes. Close all doors.

2.5 Electrical Outage:

Loss of electricity will result in diminished hood flow and poor air quality in many parts of Hamilton. If the power fails for more than 10 minutes, do the following:

- After hours, call 402-47**2-2222** to notify the campus of the power failure.
- Extinguish any open flames and turn off any electrical equipment that might cause damage (hot plates, solvent stills) or be damaged (vacuum pumps) when power is restored.
- Either shut down processes and reactions or make sure they can be left unattended for an extended period.
- Cap all open containers of chemicals, especially ones have volatile solvents.
- Close all hood sashes to minimum aperture.
- Shut and lock all doors.
- Leave the building by the stairs.

When the power returns, do the following:

- Wait at least 10 minutes after power is restored to reenter a lab:
- Upon returning to the laboratory, check for any strange odors.
- Reset/restart/check equipment as necessary.
- Check to ensure airflow of your fume hood has been restored. If hoods have not been restored, keep the sashes closed and leave the lab. During working hours, call the business manager (402-47**2-5312**); after hours call 402-47**2-2222**.

2.6 Intruder or Active Shooter

2.6.1 Intruders/Unauthorized persons in Hamilton

The department has suffered losses due to theft, and the presence of unauthorized personnel after normal hours raises concerns about personal safety. If you notice a suspicious person in the hallways of Hamilton Hall, call the Campus Police:

- The emergency **Red** telephones are an excellent choice. If you feel in danger, you do not need to speak; once the phone is left off the cradle (hook), the police will come to investigate.
- 402-472-2222 or 2-2222 from a campus phone; tell the operator why you called.
- If you feel threatened, use any exit as way to retreat. YELL for help. If you can, retreat into a lab or office and lock the door. Call 911 or 402-472-2222. Stay on the line and give your location.
- NEVER prop open exterior doors. Anyone authorized to be in the building should either have access or should have a particular person who is letting them in.
- If you are concerned by the presence of an unknown person in the building, calmly retreat to a safe distance or a secure office and then call the UNL operator.

2.6.2 Active Shooter

If you are faced with an armed intruder remember **Run – Hide – Fight**:

Run - If there is a clear and safe escape route
Hide - If there is no escape and you can get to a secure location to hide
Fight - If your only option is to defend yourself, fight as if your life depended upon it

If you receive a report of an armed intruder elsewhere in the building or nearby on the campus, lock yourself into a secure area (office, lab) and call 911 or 402-47**2-2222** to notify the authorities of your location.

Resource: *Shooting Incident:* http://emergency.unl.edu/procedure/shooting-incident

2.7 Terroristic Threat (discussed in terms of bomb threat)

If you receive a threat (in person, by phone, or by e-mail/text or other digital means of communication, listen carefully to the details of the threat and try to keep the caller talking or communicating until you are able to get the answers to the following questions: where is the bomb? When will it explode? Who is targeted? What type of bomb or weapon? *Try to remember anything about the call; is the caller male or female; is there a particular manner of speaking or accent, etc.?*

DO NOT HANG UP-let the person making the threat hang up first. If the call comes in on a campus phone (land line), dial *57 as soon as the caller hangs up; this will initiate a trace; follow the prompts. THEN… call 402-472-2222 or 2-2222 or 911 or use the Red Phone and report the bomb threat. Stay on the line and follow instructions provided by the operator.

2.8 Accident reporting

- The following must be reported to the Safety Chair and to EHS:
  - Any chemical exposure (whether or not treatment is required); any explosion or fire; any significant chemical spill (that requires a spill kit, for example), any accident that requires medical treatment.
  - Injuries of anyone being compensated for services to UNL:
  - Student Injury reporter: https://scsapps.unl.edu/studentinjuryillnessReporter/
  - Employees: http://ehs.unl.edu/sop/accidents-and-injuries
- "Near misses", incident that could have been a serious accident should also be reported as described above. Examples of near misses: minor burns, chemical exposures, or cuts/lacerations that did not require outside medical treatment. *We are not seeking to penalize anyone but to learn about potential dangers so that we can improve our practices.* https://scsapps.unl.edu/EHSNearMissReporter/

3 Engineering Controls and Safety Equipment

3.1 Fire Extinguishers

3.1.1 Types of Extinguisher:

Carbon Dioxide (CO_2) ***extinguishers*** (wide "cone" nozzle) are useful on most types of fires, including electrical fires. Do not use a CO_2 extinguisher on a fire involving a burning metal (e.g. Li, Na, K, Cs), organometallic reagent, or metal hydride ($LiAlH_4$).

Dry Chemical (POWDER) ***extinguishers*** (narrow hose nozzle) work well on any fire and are the extinguisher of choice for burning metals or metal hydrides. However, the fine particulates will ruin electronic equipment. Do not use these on a fire near computers or any electronics. Never discharge dry powder extinguishers on or towards anyone else.

3.1.2 Operation:

- Lift extinguisher from the wall holder.
- TWIST THE KEY to break the retaining strap.
- PULL the KEY out. [The "Key" usually has a round appearance.]
- Aim the nozzle at the fire.
- Depress the handle to commence extinguishing the fire,. Each extinguisher has enough propellant for 15-25 seconds of continuous discharge.
- After the fire is extinguished, call Facilities Management (402-472-1550) and ask for replacement of a depleted extinguisher. They should be called even if the extinguisher has been used only for a few seconds.
- Resource: http://ehs.unl.edu/sop/s-fire_safety.pdf(rev 7/12)

3.2 Hoods

3.2.1 "Fume" hoods or exhaust cabinets

http://ehs.unl.edu/sop/s-lab_hood_use.pdf (rev 9/13)

- Fume hoods protect you by confining chemical vapors within the hood and exhausting them from the building. Most work with hazardous materials should be done in a fume hood.
  - If there is any risk of splash or strongly exothermic reaction or small explosion,

use an additional shield and close the doors of the hood or the hood sash. The splash/blast/explosion shields are not meant to contain a powerful explosion but to protect you against a splash. Talk to the research director and/or the Safety Chair if you have a reaction or process where an explosion seems possible.
    - The hoods are not meant to contain powerful explosions; contact EHS and/or the Safety Committee before conducting any experiments with known explosives.

- Hoods are inspected annually and certified by UNL Building Systems Management.
    - if you suspect a hood is not working adequately , check to see that the hood is switched on and then contact the Building Manager (2-5312).
    - If a hood has been "red tagged" (as inoperable) or tagged with a warning, DO NOT USE IT. Contact the Building Manager.
    - Fume hoods are only effective if they are not excessive blocked. Do not use the hoods for storage. Do not place so much equipment in the hood that airflow is impeded. Do not allow paper or foil to be drawn into the hood as this will impede airflow. Remove non-essentially flammable solids and liquids from the fume hood during operation- should a fire or explosion occur these extra materials will serve add additional fuel.

3.2.2 Laminar Flow Hoods

Laminar flow hoods are not designed to protect you but to protect the items in the hood from contamination. These hoods should never be used with materials that will generate toxic, corrosive, or highly flammable fumes. Laminar flow hoods should not be used with pathogenic biological agents.

3.2.3 Biosafety Cabinets

Biosafety cabinets are designed to protect the researcher from exposure to pathogenic biological agents and protect the items in the hood from biological contamination. Biosafety cabinets should never be used with materials that will generate toxic, corrosive, or highly flammable fumes, and Bunsen burners should not be used within the cabinet.

3.2.4 High Hazard Lab

The 9th floor "High Hazard" lab consists of several facilities, a small hooded area and several "blow out" rooms. The hooded area (two hoods) currently houses a medium-pressure hydrogenator ("rocker"). The blow out rooms are heavy-walled vaults originally designed for reactions which could develop high gas pressures leading to vessel rupture; they are not intended to contain large-scale explosions.

Ironically, there are unique hazards associated with use of the "High Hazard" space.

- There is only one way in or out;
- There is no emergency phone;
- The space is remote from the rest of the building.

Researchers wanting to use the "High Hazard" space need to contact the Safety Committee Chair ahead of time and should be prepared to talk about the rationale for use of the space and what safety measures (carrying a cell phone, arranging for a "research buddy" (someone who will periodically check on the experimenter) are available.

3.3 Safety Showers

Safety Showers are present in the doorways to most laboratories of Hamilton Hall. *You should be able to find the nearest shower without looking!*

- The showers are actuated by metal levers recessed in walls near lab doors or by rings hanging over doorways. Pull the lever or ring to initiate the flow of water.
- Do not be concerned about the lack of floor drains. Your only concern is to put out the fire or remove the chemical.
- Safety showers are inspected by UNL Facilities (Building Systems Management) annually.
- If someone is on fire or covered with a corrosive chemical, there is no time to be polite; push the person under the shower and help him or her begin removing contaminated clothing and follow the emergency procedures already described for these exposures. Offer your lab coat as a cover-up.
- Notify the Building Manager or Facilities Management for clean up. If a noxious chemical was involved, start by calling EH&S.
-

Resource: *Emergency Eye Wash and Shower Equipment (rev 2/13)* http://ehs.unl.edu/sop/s-emerg_eyewash_shower.pdf

3.4 Eye wash fountains

An eyewash must be available in any lab using hazardous materials. Most eyewash fountains are near sinks. A few labs have an eyewash hose (looks like a nozzle) located near the safety shower (in the doorway). You need to be aware of the location of the nearest eyewash. *Could you find your way to an eyewash or shower if you had just splashed acid into your eyes?*

- Eye wash fountains or hoses must remain accessible.
- Eyewashes must be tested weekly. The testing must be documented on a log or checklist maintained in a visible location (multiple eyewashes can be logged on the same list).
- If you suffer a splash of chemical in your eye, use the **eyewash fountains** or hoses immediately. Do not worry about making a mess.
- Hold open the eyelids and pass the water over the eyeball(s intermittently, allowing time to recuperate between eyeball rinses. Rinse your eyes for at least 15 minutes and then seek medical attention (below).
- If students get something in their eye, make sure they rinse their eyes thoroughly (see above) and then escort them to the Health Center (Emergency Room at night or on weekends). Call first (402-472-5000 and make sure the Health Center will be available. If the Health Center is not available, visit an urgent care center or the Bryan West Emergency Room (2300 S. 16th, Street, 402-475-1011).
- If someone who cannot be treated at the UNL health center gets something in his or her eye, rinse their eyes thoroughly (see above) and then escort them to a hospital emergency room.

Resource: http://ehs.unl.edu/sop/s-emerg_eyewash_shower.pdf

3.5 Hazard Notification (Door Placards)

Each door in a laboratory or laboratory-related area that directly or indirectly accesses a hallway (includes hallway gas closets; lab doors that open into group offices) must have a standardized posting describing hazards and up to date emergency contact information.

The faculty investigator or lab director is responsible for arranging for updates of the door placards. The changes must be made through EHS so that the central campus systems accessed by EHS and emergency responders can also be updated. To arrange for changes in the posting, Contact Dan Olsen at UNL EHS: 2-4925 (402-472-4925) or dolsen2@unl.edu.

Describe the room number and a description of the change needed. Door placards are prepared by EHS and must be attached upon receipt to the appropriate entrances.

Update the door posting whenever the hazard level changes or whenever the contact information is out of date. *We encourage looking at your door placards at the end of each semester.* The person(s) listed on a door posting should be qualified to discuss the research or activities taking place in that particular space.

> For research labs, it is recommended to include work and after hours contact info for the PI and at least one back up (a lab manager, a senior student or a postdoc). The Safety Chair can be listed as a third point of contact. For spaces other than research labs, the person managing or directing the lab should be listed first, followed by the Safety Chair. If there is another individual who would also have close knowledge related to the space, he/she can be listed ahead of the Safety Chair.

Laboratories or facilities employing biohazards, radioactive materials, high-energy lasers, and certain classes of select agents or highly toxic …. are required by law to have special warnings. Contact EH&S (2-4925) or visit http://www.ehs.unl.edu for more detail:

4 Personal Protective Equipment (PPE)

4.1 Eye Protection:

You must, by Nebraska law, wear approved **safety glasses** or **goggles** in labs or chemical facilities in Hamilton Hall. *Personal Protective Equipment (PPE)- Eyes and Face (rev 11/15)* http://ehs.unl.edu/sop/s-PPE_eyes-face.pdf.

Exceptions: Safety glasses and goggles are not required in the following areas: offices, conference rooms, classrooms, hallways, elevators and the following lab areas**:** M. Stains lab (6th floor); "NC3" labs on 4th floor (Zeng, Li, Francisco). Lab/facility directors may request an evaluation by the Safety Committee evaluate of whether other laboratory areas may be exempted from the requirements for eye protection and/or use of laboratory coats. The Safety Committee will gather information about the potential hazards (corrosives, oxidants, flammables, sharp objects, light or heat sources, compressed gases, vacuum, etc.) present in the space under discussion and will make a formal recommendation to the Department Executive Committee and Chair.

(Dealing with chemical exposure to the eye: See section 3.4)

4.2 Required clothing and lab coats

- Personnel engaged in research must wear lab coats; the only exceptions are in areas where safety glasses are not required.
- As of 2015-16, Chemistry is using cotton or cotton/polyester lab coats with an ARC fire-resistance rating of 7.7). Lab coats are dispensed through the research stockroom. Return your coat for a fresh coat on a regular interval or whenever soiled.
- Lab aprons should be worn over a lab coat when working with significant volumes of corrosive materials (for example, acid baths).
- You are excused from using lab coats when wearing one would result in increased hazard (for example, working near certain machinery with moving parts or a spinning belt). However, consult with the research director and/or the Safety Chair to verify that you are

adequately protected towards chemical hazards while working without a lab coat.

- Open-toed shoes are forbidden in laboratories, i.e. *NO* sandals or flip-flops or "Crocs". Dangling jewelry, ties, scarves, and loose billowy sleeves are not appropriate for laboratory. Legs should be covered by the combination of clothing and the lab coat.
- Long hair (hanging below shoulder), should be secured for lab work. TA's in undergraduate laboratories should be careful to enforce this rule.
- Other protective equipment

A **face shield** should be used in addition to safety glasses or goggles for experiments where there is a chance of explosion, splashing, or violent chemical reaction.

4.2.1 Laser goggles

Work with high power **lasers** requires special safety measures:

- The doors to the facility must notify persons seeking to enter the facility that a high power laser is (or is not) in immediate use and special goggles must be put on before entering.
- Appropriate goggles should be at hand at the entrance to each laser facility. Goggles should be put on before entering the facility.
- Reflection from an unprotected surface is a serious problem. Thus, most laser facilities have walls painted with flat black paint or curtains of dark cloth.

Resources: Consult the faculty or staff member in charge of the facility and look at *Laser Safety (EHS): http://ehs.unl.edu/sop/laser-safety*

4.2.2 Protective goggles (Ultraviolet photochemical reactors)

High power UV sources give light that can lead to temporary or even permanent eye damage (and give you a tremendous sunburn) after only a brief exposure.

The reactor must either:

be used within a sealable assembly/box or operated within a space (e.g. a hood) that can be covered with aluminum foil) so that the intense light does not escape.

If the reactor cannot be operated behind shielding, then you must use specialized UV protective goggles* and a UV-protective face shield* and a lab coat and gloves that will protect your hands against UV*. (* Consult with EHS). You will also need a protocol to prevent others from entering the lab while the UV lamp is in operation.

Doorways should be posted with warnings if an unshielded reactor is in use. UV-protective goggles must always be in place, BEFORE you enter such a facility.

4.3 Protective Gloves:

Hand protection is necessary for handling hazardous materials, when handling hot glassware, or when working with materials at very low temperature. See *Personal Protective Equipment (PPE) - Hand Protection (rev. 11/2015)* http://ehs.unl.edu/sop/s-ppe-hand_protection.pdf

A variety of protective gloves are available through most major scientific suppliers.

- Latex gloves are **not recommended** due to the potential for allergic reaction.
- No one type of glove is resistant to all chemicals. "Nitrile" gloves, which are used heavily throughout the building, are "single-use" PPE that have only moderate resistance to a number of chemicals. Once removed from the hands, they must be discarded.
- If you spill a chemical on a disposable glove, remove and replace the gloves immediately.
- Gloves must be removed before the researcher leaves the research lab, touches the doorknobs, or uses a telephone (anything that someone might reasonably touch without

gloves).

- Researchers should **wash hands** upon removing gloves.
- A glove that is used as a barrier against continuous exposure to a hazardous material (for example, if you are immersing a hand in a dangerous cleaning solution) must have thickness and composition suitable for the use. Consider alternatives (for example a plastic basket or tongs).
- Information on glove compatibility with various organic solvents, or corrosive chemicals can be found at:
  - Ansell Chemical Resistance Guide, 7th edition: http://www.ansellpro.com/download/Ansell_7thEditionChemicalResistanceGuide.pdf (focus on thicker gloves)
  - *Chemical Resistance of Gloves* http://amo-csd.lbl.gov/downloads/Chemical Resistance of Gloves.pdf

4.4 Respirators

Respirators, dust masks, or other devices intended for airway/breathing protection (includes dust masks) may only be used by persons who have had appropriate health testing and fit testing/training suitable for the device. Contact EH&S for more information (2-4925). *Respiratory Protection Program (rev. March 2015)* http://ehs.unl.edu/programdocuments/respiratory_protection.pdf

5 Gas Cylinders, Broken glass, and "Sharps"

5.1 Use and Handling of High Pressure Gas Cylinders

5.1.1 Storage

- Cylinders MUST ALWAYS be secured to the bench, a wall, or a solid beam with a heavy strap or metal chain around the upper half of the cylinder.
- A safety cap or regulator must always be attached to the cylinder. Cylinder valves should be closed when not in use and pressure bled from the regulator.
- An appropriate regulator must be used with each type of gas.
- Hydrogen fluoride (HF) and HBr (hydrogen bromide) cylinders should not be stored but should be used and discarded as soon as possible. The reaction of HF or HBr with the metal interior of the cylinder results in the buildup of very high pressures (>2000 psi) of hydrogen.
- Highly reactive or toxic gases (e.g. borane, arsine, silane) may require special procedures and proper gas storage cabinets. Contact EHS (2-4925) for more information.
- Flammable gas cylinders should be stored away from oxidizers.

5.1.2 Transport

- Cylinders can only be moved-even within a lab- with the safety/shipping cap attached. NEVER move a cylinder –even if only a few feet- with the regulator attached; otherwise, you risk creating a 500 lb. rocket.
- A cylinder cart with a tight-fitting chain must always be used when cylinders are moved; the safety cap must be attached. This includes movements across the laboratory.

5.1.3 Leaking Cylinders

If the leak is minor and does not pose a health risk, place the cylinder in or next to a fume hood and contact EH&S. Major leaks of toxic gases (**not** nitrogen, oxygen or helium) fall under the same rules as major chemical spills (section X.Y)

Resources: *Gases Under Pressure: Hazards and Risk Minimization* http://ehs.unl.edu/sop/s-gases_under_pressure_haz_risk_min.pdf;

Compressed Gas Cylinders in Labs (rev 11/11) http://ehs.unl.edu/sop/s-gascyl.pdf

5.2 Broken Glassware

- Do not dispose of broken glassware in the trash. Broken glassware should be placed in a "Broken Glass Disposal" box, lined with a heavy-walled plastic insert. When full, the plastic sack should be folded over or taped shut and the box taped shut (so that nothing can escape). The box should be labeled "broken glass" and placed outside the lab door for removal. Commercial "broken glass" boxes are available but you can also make your home using a box no larger than 4 cu ft. (1.5 ft. or 0.5 m per side) and lined with heavy gauge plastic bags).
- Broken glass boxes should not exceed 20 lbs (9 kg) when filled.
- Never use broken glassware boxes for the disposal of any chemicals, liquids, hazardous waste, radioactive waste, or sharps. If broken glassware holds materials, it may need to be cleaned before disposal; contact EHS or the Safety Chair.

5.3 Sharps

- Examples include razor blades and syringe needles.
- Dispose of Sharps in approved *Sharps Disposal Containers.* Containers MUST NOT be filled to greater than 2/3 depth.
- DO NOT dispose of sharps in the regular trash or in cardboard glass disposal boxes.

EHS SOP: Sharps - Handling and Disposing (6/16) http://ehs.unl.edu/sop/s-bio-sharps-handling_disposing.pdf

6 Chemical Handling and Storage

6.1 Chemicals Present in Hamilton Hall

- Newly purchased chemicals are added to the departmental SysPro inventory system; bar codes from discarded reagent bottles should be retained to edit the inventory.
- Each laboratory or facility should periodically compare the SysPro listing against the physical inventory.
- Lab members must know how to rapidly access the laboratory inventory using SysPro or a local version (for example, a downloaded Excel spreadsheet) in the event of an inspection or an emergency.
- The departmental SysPlus listings can be accessed through the Chemistry stockroom (403 Hamilton) or by contacting the Safety Chair

6.2 Transporting chemicals stockroom or between labs

- **Secondary containment** must be practiced for chemicals that are not in secure metal packaging or containers.
- Commercial safety containers are highly useful. However, if your lab is not equipped with these, a simple plastic tray with side handles will suffice for smaller containers of chemicals. Larger (e.g. 4 L) jugs of acids or solvents are best transported inside a larger plastic container with carrying handle. These are available at the stockroom.
- Chemicals in heavy, non-breakable plastic containers or secure metal containers may be excused from the above "secondary containment" requirement.

- Incompatible chemicals must be segregated (separate tubs, for example) during transport.
- Exercise exceptional care while using the elevators. If a chemical spill occurs on the elevator, get everyone off on the next floor and **pull the fire alarm.** This will send the elevators to the first floor, where they will stand open. **Then,** notify the emergency operator (**Red** Phone or 402-472-2222) that there has been chemical spill on the Hamilton elevator.
- For larger quantities (e.g., multiple bottles), the use of laboratory carts is encouraged (instead of trying to carry multiple containers); each container should be in secondary containment.
- Chemicals *still in their original shipping container* may be transported as received (no additional containment required). Do not open shipping cartons in the receiving stockroom; instead, transport the shipping container to your lab before opening.

6.3 Transporting/shipping chemicals between buildings or off of the campus.
Contact the Safety Committee Chair or EHS.

6.4 Chemical Risk Assessment

Unless you are an expert with a procedure, start your planning by evaluating the hazards of the procedure and materials you plan to use.

- What is known about the procedure? What are the GHS hazard classifications (more below) on the starting materials?
- What are the expected products and byproducts? Again, what are the expected GHS hazard classifications of the products? For example, an experimenter using oxalyl chloride, ClC(=O)C(=O)Cl might think the major hazard is the corrosive nature of the reagent. However, many reactions of oxalyl chloride liberate stoichiometric amounts of carbon monoxide and HCl, either of which may be a major hazard.
- Will the reaction liberate gas? (pressure hazard); is it exothermic (do the procedures call for cooling)?

Chemical Risk Assessment (rev 12/13) : http://ehs.unl.edu/sop/s-chemical_haz_assessment_risk_min.pdf

6.4.1 GHS Hazard Identification

The Globally Harmonized System (GHS) is a worldwide system which classifies chemicals by the nature of hazard and by the potential for injury or damage. Categories commonly seen in Hamilton Hall include: flammable liquid, flammable gas, oxidizers, corrosives (skin, eye), toxicity (dermal, inhalation, swallowing), and environmental toxicity. Hazards are ranked from 1 (most serious) to 4 (much less serious). Researchers should evaluate the nature of the hazard in terms of both the chemical hazard (e.g., a "1" on toxicity) and the possibility of exposure (for example, a category 1 toxic gas is far more serious as a hazard than a category 1 toxic solid. EHS is prime resource for evaluating chemical and physical hazards and making recommendations on how to minimize the risks. Contact them if you have questions.

For an overview of this area, see http://ehs.unl.edu/sop/s-chemical_haz_assessment_risk_min.pdf.

6.4.2 SDS/ MSDS sheets.

Safety data sheets (SDS or MSDS) will arrive with most purchased chemical, and can also be easily located on the Internet. Example: search "iodomethane". Sigma-Aldrich will come up as one of the top hits. Click on "MSDS" or "SDS" and you will see all of the GHS standardized warnings (see below) for this molecule (and you will note that it carries the most serious "1" designation in several areas).

6.4.3 Other Resources re Chemical Hazards

- *NIOSH Pocket Guide to Chemical Hazards.* Available and searchable on-line at http://www.cdc.gov/niosh/npg/. Download available at same site.

- *Identifying and Evaluating Hazards in Research Laboratories;* ACS Committee on Chemical Safety, 2015. http://www.acs.org/content/acs/en/about/governance/committees/chemicalsafety.html (under "Safety Practices and Recommendations", https://www.acs.org/content/acs/en/about/governance/committees/chemicalsafety/safetypractices.html

- *Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, Updated Version* (National Academy Press, 2011). Free download available at: http://www.nap.edu/download.php?record_id=12654

- *Sax's dangerous properties of industrial materials* / Richard J. Lewis, Sr; Wiley-Interscience, 2004 (Engineering Library)

6.5 Flammable Materials

Hazards of Flammable Gases, Liquids and Aerosols & Risk Minimization (rev 1/13)
http://ehs.unl.edu/sop/s-hazards_flam_gases_liq_aeros_risk_min.pdf

Storage and Use of Flammable and Combustible Liquids (rev 7/12)
http://ehs.unl.edu/sop/s-flamliq.pdf

General Guidance for Chemical Ordering, Receipt, Distribution, Use and Storage (rev 12/13) Storage: http://ehs.unl.edu/sop/s-gen_chem_guidance_o_r_d_u_s.pdf

GHS Flammable Material classifications hazard levels from Category 1 (highest; example, diethyl ether) to 2 (acetone) to 3 (lighter fluid) to 4 (diesel fuel).

For determining allowed inventory and storage, UNL defers to National Fire Protection Association (NFPA) standards. "Flammable liquids" are liquids with flashpoints (fp) ≤ 100 °F (40 °C).They are further broken down by degree of flammability.

Class IA: fp < 73 °F and boiling points (bp) < 100 °F (similar to GHS Category I);
Class IB: fp < 73 °F; boiling point > 100 F (similar to GHS Category 2 and includes acetone, ethanol, methanol, and many other organic solvents).
Class IC: fp between 73 -100 °F; (includes some moderate boiling solvents like isobutanol, xylene, etc.)

The following are considered best practices for storage within a lab area.

	Class 1A	Class 1B	Class 1C
Glass bottle (on bench)	500 mL	1L	4L
Metal drum	4L	20L	20L

Safety can	10L	20L	20L

Larger quantities can be stored in *metal* flammable safety cabinets, either freestanding or built into hoods. It is good practice to keep all solvents not in immediate use in a safety cabinet. Flammable safety cabinets should remain plugged (vent "bungs" left screwed in). If you have previously vented metal cabinets, please reinsert the metal plug. Contact EHS if you have lost the one that came with the cabinet. Best practice is not to store flammable liquids in excess of "bench top" levels (see above) in regular cabinets or underneath hoods, benches, or sinks (unless the storage is designed for flammable materials).

6.5.1 Flammable Materials Refrigerators

- Store flammable liquids in tightly closed containers within refrigerators and/or freezers that meet specific design criteria, including no internal ignition sources.
- Incompatible chemicals (e.g., oxidants and flammable materials) must be separated even in refrigerators. This can be as simple as using plastic bags or tubs.
- "Altered" home refrigerators are not acceptable at UNL.

6.6 Incompatible Materials Storage:

The following types of chemicals should be segregated (stored separately) from other classes. Remember that segregation can use a separate location or can be as simple as having samples in a plastic tub. For a full guide, see: http://ehs.unl.edu/documents/chemical_compchrt.pdf

- Oxidizers: Examples include: Cr(VI) compounds, perchlorates, chlorates, bromine, nitrate salts, concentrated solutions of H2O2, permanganates, organic peroxides. Segregate from reducing agents, organic compounds, and combustible materials (paper, wood oils). Resource: *Oxidizers: Chemical Hazards and Risk Minimization (rev 1/13)* http://ehs.unl.edu/sop/s-oxidizers_chem_haz_risk_min.pdf

- Pyrophoric (react with air) materials and substances that emit flammable gases upon contact with water: *aka "Air-reactive" or "water reactive" materials* . Examples: metal hydrides, active metals (Na, K), boranes. Store in metal cabinets. Segregate from other materials. Store in a manner that protects the containers from the action of the fire sprinklers. Resource: *Pyrophoric & Substances that Emit Flammable Gases when in contact with Water:* http://ehs.unl.edu/sop/s-pyrophoric_%26_substances.pdf

- Inorganic acids: Segregate from organic acids, flammable organics, bases, and materials that generate toxic or flammable gases upon acidification (cyanides, azides, metals, metal hydrides. Resource: http://ehs.unl.edu/sop/s-corrosive_chem_haz_risk_min.pdf

- Strong reducing agents: Segregate from acids, organics, and oxidizers.

- Organic peroxides: Segregate from all other hazard classes. See also the following section.

- Organic acids. Storage separately from inorganic acids.

- Bases: Segregate from acids.

- Toxic/carcinogenic materials: Items with high toxicity (for example, those carrying, GHS designation "1" for dermal or inhalation toxicity) or cancer-causing agents should be segregated from other chemicals

- The **storage areas** of the above classes of compounds **must be clearly labeled** as to class of chemicals present.

6.7 Peroxide-Forming Compounds:
Some compounds can form shock sensitive and explosive peroxides upon exposure to oxygen or air. Ethers (e.g. diethyl ether, THF, and 1,4-dioxane) are the most infamous peroxide-formers but this process can also occur with some hydrocarbons, metals, and organometallic compounds. Resource (including list of peroxide formers): *Use and Storage of Peroxide-Forming Chemicals (rev 3/13)* http://ehs.unl.edu/sop/s-peroxides.pdf

The peroxides are often higher boiling than the "parent" solvent and may accumulate and detonate upon concentration, heating or abrasion.

Peroxide formers **must be dated** when first opened. These materials must be consumed or disposed within 180 days of the first opening of the container or the container must be rechecked (below) and revalidated with a new date.

A peroxide test (potassium iodide/acetic acid, or commercial test strip) may be used to gauge the buildup of peroxides. Contact the Safety Chair if you need help with this.

6.8 Use of Ionizing Radioactive Materials and Radiation Producing Devices
- Labs in which ionizing *radioactive materials and radiation producing devices are to be used must be certified in advance by EH&S. Contact the UN-L Radiation Safety Office (2-4925) to initiate the approval process.
- Specialized training is required for use of materials and devices; contact the UN-L Radiation Safety Office (2-4925).
- Special waste handling methods apply; contact the Radiation Safety Office (2-4925). NEVER move radioactive materials or radioactive waste to other laboratories without checking with the Radiation Safety Office (2-4925).
- See section 7.7 concerning hazard notification/door placards:

More information: *EHS Radiation Safety:* http://ehs.unl.edu/sop/radiation-safety

6.9 Special Hazard Warnings:
Laboratories or facilities employing any of the following are required by law to have special warnings: Biohazards, Radioactive materials, High-energy lasers/UV sources;
Contact EH&S (2-4925; www.ehs.unl.edu) for more information.

6.10 Chemical Lists and Inventory:

Each laboratory must keep an inventory of all chemicals currently present in the laboratory. This inventory must be kept up to date. This involves full chemical names, not chemical structures. It should not be placed on the door. (See section 1.3)

6.11 Chemical Security:
Chemical security safe operating procedures are posted on the Environmental Health and Safety website. The most pertinent recommendations for Hamilton Hall are:
- Keep laboratories locked when not in use

- Any suspicious persons or activities should be reported to university police (402-472-2222). If you are unsure about strangers in the building at night or weekends, you can always ask "Can I help you find someone?" and see what they say.
- Unexplained losses of chemicals should be reported to university police immediately, as should attempted burglaries, vandalism, or signs of tampering.
- Specific '**chemicals of concern'** are listed on the EHS website: http://ehs.unl.edu/sop/s-chemsecurity.pdf, which also lists specific notification procedure for the purchase and storage of specific chemicals of possible terrorist use. The following examples are not comprehensive but designed to illustrate molecules or chemicals which might be found in Do not ship (to anyone else, in any quantity) without checking with EHS: BBr3, BrF3, BrF5, MeSiCl2H, POCl3, P2S5, PCl5, TiCl4, HSiCl3.
  Contact EHS before purchasing:
  Almost any "mustard" (chloroalkylsulfides, chloroalkyl amines; nerve agent (e.g. Sarin, Soman or phosphonyl difluorides).
  Reactive gases, including: AsH3, ClF5, ClF3, cyanogen, N2O4, F2, GeH4, hexafluoroacetone, HCN, HF, H2S, H2Se, MeSiClH2, NO, phosgene, SF4, CF3C(O)Cl.
  Contact EHS before purchasing >100 g of the following: AsCl3, many phosphoryl/thiophosphoryl dichlorides, thiodigyclol.
  Contact EHS before purchasing or receiving > 4 lbs of the following:
  examples: BBr3, BCl3, BrCl, BrF3, N2O3, NOCl, PCl3
  Contact EHS before purchasing or receiving > 100 lbs of the following: Concentrated nitric acid, nitrobenzene, POCl3, triethanolamine (free base or HCl salt).

6.12 Chemical Container Labeling

This section discusses labeling of chemical containers used for reagents, reactions, and stored products: Labeling of "waste" containers is discussed in section 7.

The big picture: All flasks or containers of chemicals that are not "transient" (defined below) must be labeled in a manner that allows identification of significant components. This applies even to containers of oil or water or soap.

NEVER use empty food containers, even if relabeled, for storage or dispensing of chemicals.

Chemical Container Labeling (rev 6/13): http://ehs.unl.edu/sop/s-chemlabelguideline.pdf

6.12.1 Manufacturer labeling;

Containers provided by a manufacturer will normally carry name/product identifier, supplier, hazard pictograms or warnings. *If you repackage commercial material, you should supply this information on the repackaged bottles.*

6.12.2 Durable containers.

"Durable" containers are those not provided by the manufacturer and intended for use that extends beyond a work shift or which are shared by multiple users or are stored/used in an area used by more than one person. Almost any custom-prepared reagent or solvent solution would be stored in a durable container; the same would be the case for a stock solution.

Minimal labeling of durable containers consists of product identifier/chemical name (concentration is recommended, but not required) or a structure or condensed chemical formula; anything that permits unambiguous determination of the contents. The name can be an acronym or shorthand abbreviation if a cross-reference between the full chemical name and the

shorthand name is posted in the work area. Label with media that will not easily smear or fade (printed labels much, much better than Sharpie/handwritten labels for durable).

Each laboratory must have posted in an obvious place a list of any abbreviations used for stored chemicals used in the laboratory (e.g. “TFA” for “trifluoroacetic acid”).

Reaction vessels or sample tubes can be labeled as above or with a reference to a notebook or log enabling immediate determination of identity.

Small containers, such as vials and test tubes, can be labeled as a group by labeling the outer container, rack, or box. Alternatively, a placard can be used to label the storage location for small containers (i.e., shelf, refrigerator, etc.).

Guidelines: http://ehs.unl.edu/sop/s-chemlabelguideline.pdf

6.12.3 Transient Containers

Transient containers are used to hold chemicals for less than one work shift and that will be under the control of the person filling the container (not shared, not in an area routinely used by others). http://ehs.unl.edu/sop/s-chemlabelguideline.pdf

No labeling is required as long as the containers are consumed (used up) by the end of the work period (usually day) and remain completely under the control of the person who prepared them. Examples include solutions that will be used immediately in an experiment and cleaning solutions that will be used by the end of a shift.

If a transient container is moved to any shared-use area, it becomes a durable container and must be labeled accordingly (see previous section).

However....be careful: many “unknowns” begin life as forgotten transient containers.

6.13 “Open” Chemicals

Flasks, beakers and other containers **must be capped** when not in active use. This is to reduce air pollution from this source; failure to do so is grounds for citation.

Volatile organic chemicals (VOC) must **never be left open** to the air, unless in immediate use.

No container that could be construed as “waste” ("used", "recovered", "spent", etc.) may be left open to the air. Self-closing funnels (for example, *Eco Funnels)* may be used on containers of chemicals to be disposed in the near future.

6.14 Samples taken outside the lab for spectroscopy or analysis

Researchers should be aware that NMR solvents are not necessarily inert. D_2O and deuteromethanol are obviously reactive towards strong reducing agents or organometallics but so are dimethylsulfoxide and acetonitrile. Improperly stored chloroform can be very acidic. It is your responsibility when making up an NMR sample to ensure that the substance does not react with the solvent.

If an NMR sample shows evidence of undergoing a chemical reaction (heat, gas evolution, color change) do not attempt to get a spectrum. Instead, IMMEDIATELY get the tube into a fume hood. The NMR lab is one of the few instances where we handle potentially

dangerous materials outside a hood, and one needs to be extra cautious for that reason. Any experiment involving a chemical reaction inside an NMR probe should be discussed, IN ADVANCE, with the Director of the Research Instrumentation Facility.

NMR samples need secondary containment, just like any other container of potentially hazardous material.

You should be aware of the toxicity and general reactivity of ANY compound you are working with. If you are running an NMR spectrum (or submitting an HRMS analysis) of a material that is highly toxic, alert facility staff of the potential hazard.

7 Disposal of Chemicals:

7.1 Used/spent/recovered/waste chemicals: definition and labeling standards.

Any chemical scheduled for disposal or that should be scheduled for disposal* is considered a "waste" chemical.

This includes chemicals that are "spent", "used", "waste", or "recovered" longer needed or in useful condition).

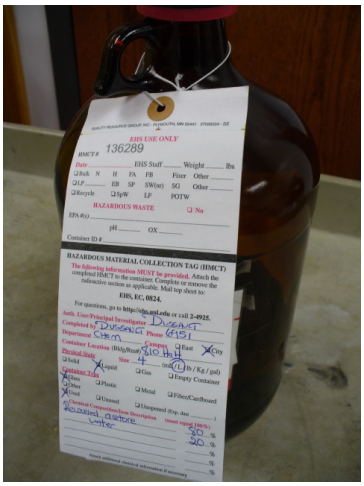
If you are needlessly storing a chemical that should have been disposed (for example, a sample described as "poor quality" or "throw away" or an obviously decomposed sample, this could be considered a waste sample that was not dealt with.

If you have chemicals in your lab that are "waste" (as defined above), they need to kept fully labeled (full name of all major components), and in a container and space compatible with the waste. For example, a highly acidic corrosive waste should be kept in a container (probably glass) stable to acid. A highly flammable waste mixture should be stored in a flammable safety cabinet. As soon as the container is full or the process that generates the waste comes to a close, the container must be immediately tagged for disposal by EHS (see below).

7.2 Disposal of Chemicals

Nearly all chemicals must be disposed via EH&S: (402-472-4925). *Hazardous/Radioactive Material Collection Procedures:* http://ehs.unl.edu/sop/s-chem_collection_procedures.pdf

- "Disposal tags" are available through EHS (402-472**2-4925**). The disposal tag must be attached to the container containing the chemical(s). The process you used to collect the material should give you the knowledge to estimate the composition of the container (e.g., "60% methanol, 39% water, 1% acetic acid"). Components of the container must total 100%.
- Full written chemical names must be used, not chemical structures or abbreviations. An example of a typical filled out disposal tag is shown at right.
- The top copy of the disposal tag is removed and mailed to EHS using the address on the tag. EHS personnel will come to pick up the chemical for disposal. (Exception: If EHS visits your lab on a regular basis for collection, they may be willing to simply look for "tagged" disposal bottles during the visit. Contact EHS if you have any questions.
- The container must carry the same list of chemicals as the tag sent to EH&S.



- “ALL chemicals” include excess reagents (commercial or prepared solutions no longer needed), reaction byproducts, extraction solvents, old pump oil, and cleanup materials from spills.
- A very few chemicals may be disposed of using the trash can or drain (sanitary sewer); the lists at the following URLs should be consulted before disposal of any chemical via the drain. If in doubt, let EH&S decide.
- *Items Prohibited from Trash Cans and Dumpsters (rev 8/16):* http://ehs.unl.edu/sop/s-dumpster_ban.pdf
- *Sewer Disposal List:* http://ehs.unl.edu/sop/s-sewerdisp.pdf
- *Disposing of Biohazardous Materials* (rev 12/11) http://ehs.unl.edu/sop/s-bio-dispose.pdf
- If you are planning a major chemical disposal (e.g., a lab "spring cleaning"), contact the Safety Committee or EHS in advance; it may save you some work.
-

7.3 Green chemistry practices

Experiments and workups should be conducted so as to minimize production of waste materials. “Green Chemistry” should be practiced whenever possible. The American Chemical Society Green Chemistry Institute, which promotes *The Twelve Principles of Green Chemistry: http://www.acs.org/content/acs/en/greenchemistry.html.*

Periodically look at your standard cleaning, compound isolation, and compound purification processes to determine if they can be accomplished using a smaller amount of chemical or a less hazardous material.

Excess chemicals from your lab can be transferred to other labs. Make sure that the new "owners" transfer the location associated with the bar code in the departmental inventory system.

- EH&S may redistribute chemicals that are in good shape. Contact EHS before disposing of large quantities of otherwise valuable chemicals.
- As of 2016, any repurification of a chemicals for reuse that requires a separate processing step (e.g., distillation) is discouraged. If you have a chemical that needs to be recycled for reasons of cost or volume, please discuss this first with EHS as there are new federal requirements that must be met BEFORE DOING ANYTHING.

7.4 “Unknown” Chemicals

The EPA automatically considers any chemical whose identity can not be immediately established as a "Hazardous Material".

- Unknown materials discovered during a state or EPA inspection may be sent out for analysis. If found to be a hazardous material (remember, this includes flammables, most acids and bases, oxidants, water-reactive, etc.), the university could be assessed a fine of $25,000 for each sample, multiplied by the number of estimated days the sample was present.
- If unknown materials are found in your lab, try to identify them using appropriate spectroscopic or chemical tests. Then dispose via EH&S, or use them normally.
- If the unknown materials still cannot be identified, contact the Safety Committee and/or EHS.
- Unauthorized transfer or disposal of unknown materials ("dumping") is considered illegal chemical disposal ("dumping") and may be grounds for disciplinary action.

7.5 Empty Containers (*Empty Container Disposal, rev*

Empty solvent containers should be allowed to air out until no odor is present. Mark the containers as "EMPTY" (use black marker) and "X" out the original name. empty and dry containers can then be placed in the hallway with caps removed for custodial disposal.

- Glass containers ≤ 500 mL should be disposed of via a broken glass box.
- Containers with a residual odor or which contained higher-boiling residues be rinsed with acetone and then with soapy water prior to evaporation and disposal.
- Empty containers, which held acutely hazardous chemicals (see the list at the end of the SOP described below must be tripled-rinsed with a suitable solvent and the rinsate used prior to disposal of the container or the container needs to be tagged for collection by EHS.
- See *Empty Container Disposal (rev 6/2016):* http://ehs.unl.edu/sop/s-empty_container_disposal.pdf

8 Special Hazards

8.1 Biohazards.

8.1.1 Training and Control Mechanisms

8.1.2 Select Agents

The United States Department of Health and Human Services (HHS) and the United States Department of Agriculture (USDA) have established regulatory requirements for the possession, receipt, or transfer of biological agents capable of causing substantial harm to human, animal, or plant health and having high risk agents for illegitimate use. The types of select agents most likely to be encountered in research in Hamilton Hall would be toxins (e.g. botulin toxin, ricin toxin, and plant pathogens. A full description can be found at: *Select Agents (rev 12/2014)* http://ehs.unl.edu/sop/SA_SOP_SelectAgents.pdf.

Contact the Safety Committee Chair and/or the EHS Biosafety Officer with any questions.

8.2 Magnetic fields

Superconducting NMR spectrometers generate magnetic fields capable of erasing credit cards, ruining watches, moving newly implanted stents, and stopping pacemakers, neural implants and diabetic syringe pumps. Entries to high magnetic field areas must bear appropriate warnings The 5 Gauss lines are marked on the floor surrounding these magnets. Hamilton Hall has such areas on 8th floor, 4th floor, and in the basement.

A rare but serious hazard is an NMR "quench." Large quantities of helium will be released to the atmosphere, potentially causing a local asphyxiation hazard. If you are using an NMR spectrometer and you observe a major release of gas from the magnet, leave the area and do not re-enter until cleared.

8.3 Vacuum Pumps, Lines and Desiccators

- Belt guards are required on all belt-driven vacuum pumps.
- If vacuum pump exhaust might contain hazardous gases (for example, in the case of a Teflon/"dry" vacuum system used to support rotary evaporation or an untrapped high vacuum system used to strip off a toxic solvent), the exhaust should be vented into a fume hood.

- Safety goggles *must* be worn around evacuated glassware such as vacuum lines and desiccators, due to implosion danger. Large glassware subjected to vacuum (e.g. desiccators), should be wrapped with strong tape to reduce the danger of flying glass if implosion occurs.

8.4 Motors and mechanical devices

All moving belts and components of powered mechanical devices (pumps, for example) should be shielded and precautions must be taken before servicing any such equipment. Experiments should also tie back long hair and remove or secure any loose clothing (sleeves, scarves, ties). If the use of a lab coat would create additional danger, then lab coats need not be worn: See *Lockout/Tagout (LO/TO) for Machines and Equipment:* http://ehs.unl.edu/sop/s-loto_program_overview.pdf

8.5 Electrical safety

Use of electrical equipment can raise unique hazards. The EHS SOP is helpful in this regard*: General Electrical Safety (rev 1/14) http://ehs.unl.edu/sop/s-electricalsafety.pdf*h
The following are problems that have been observed in Hamilton Hall:
•Use of outlet strips or extension cords in place of a permanent electrical hook-up;
•Use of older equipment that is not UL-rated nor has been inspected by an electrical professional
•Use of equipment with frayed or damaged cords.
•"Daisy-chaining" two or more extension cords or outlet strips (raising the risk of overloading the circuit).
•Use of electrical equipment or cables too close to water (Any outlets close to a sink or water source are supposed to be GFI (ground fault interrupter) protected.
(*In case of questions, consult with the electronics shop).*

8.6 Cryogenic Operations:

- Explosion danger: Vacuum traps must be immediately vented once coolant is removed in order to avoid a rapid increase in pressure that can result in a gas explosion. This is particularly important for traps cooled in liquid nitrogen (LN2)
- Fire/Explosion danger: Vacuum traps immersed in LN2 condense significant quantities of liquid oxygen (LOX). In addition to the pressure hazard noted above, users must be alert to the significant possibility of a violent explosion upon co-condensation of LOX and flammables organic. A safety shield should be placed in front of traps suspected of containing condensed LOX.
- LN2 transfer dewars should be dumped at the end of each work day.
- LN2 as well as slushes formed from dry ice with solvents can produce serious frostbite almost instantly if either come into contact with bare skin. Heavy gloves (insulated leather) should be used for cryogenic work. Eye protection should always be worn when working with cryogens.
- Asphyxiation danger: The "boil off" from large LN2 dewars does not support life. Rooms used for the long term storage of large quantities of cryogenic materials (liquid nitrogen or helium) should be actively ventilated.

9 Safety Training and Assessment

9.1 EHS Web-based training (http://ehs.unl.edu/web-based-training)
Anyone working or conducting research within Hamilton Hall (whether as an employee, student, collaborator, or visitor) must complete safety training as described below. Note: this includes all students who may be teaching assistants in chemistry teaching labs. Exceptions must be approved -*in advance*- by the Safety Committee Chair and will be limited to persons who will be in Hamilton Hall for a short period, will be conducting activities considered fundamentally nonhazardous, and will be under the continuous supervision of an experienced researcher or worker who has completed all necessary training. See "required safety training" at http://chem.unl.edu/safety).

The following EHS modules are required of **everyone** who works or conducts research in Hamilton Hall with the exception of short-term visitors and undergraduate students who are in Hamilton only for lectures or undergraduate teaching labs). The training is typically web-based but live sessions are sometimes available.

- 1. Core-Emergency Preparedness Training
- 2. Core - Injury and Illness Prevention Plan (IIPP)

Any personnel who may come into contact with hazardous materials, including all persons who may become departmental teaching assistants), must also complete the following modules:

- Chemical Safety Training (4 subunits)
- Personal protective equipment (PPE)
- Fire Extinguisher training:

Depending upon the nature of hazards associated with your research or work (e.g., Biohazards, HF, radioactive materials), additional training may be required.

9.2 Departmental Training
Departmental training and Assessment All persons working or conducting research in Hamilton Hall are required to complete departmental training and assessment. Any exceptions must be approved by the Safety Committee Chair and will typically be limited to persons who will be in Hamilton Hall for a short period, will be conducting activities considered fundamentally nonhazardous, and will be under the continuous supervision of someone who has completed all necessary training.

- The Chemistry Safety Committee conducts this assessment, which focuses on issues specific to Hamilton Hall. Attendance will be taken and successful completion of a short assessment is required.

- Personnel who arrive at a time when no upcoming briefing is scheduled will be given the briefing material to study, and then examined on the contents. No one may work in a laboratory in Hamilton Hall prior to taking this training.

9.3 Other training and additional training resources.

- The training and documentation described above, while extensive, does not cover the full range of research and research-related activities pursued within Hamilton Hall. Some areas of research or work may require additional training (for example, work with concentrated HF solutions). Students, faculty and researchers should take advantage of the extensive list of Safe Operating Procedures (http://ehs.unl.edu/sop) posted by UNL

Environmental Health and Safety. A link to EHS-provided training can be found at: http://ehs.unl.edu/web-based-training. Consult the EHS *Training Needs Assessment* for more detail: http://ehs.unl.edu/Training_Needs_Assessment.pdf

Selected topic (presented for illustration): Biosafety Containment Levels; Disposing of Biohazardous Materials; Hydrofluoric Acid; Cryogenic Material; Nanoparticle Safety; Pyrophoric Chemicals; Centrifuge Safety; Compressed Gas Cylinders in Laboratories; Exposure Control for Chemical Reproductive Hazards (7/09)

9.4 Training records

EHS: The EHS system automatically logs and organizes training records for registered UNL students, as well as anyone paid as an UNL employees. All others (new students not yet registered, visitors, short-term researchers, etc.) must print out the record of completion of training and provide that to the Department of Chemistry (Safety Chair or else the person handling the appointment paperwork).

Departmental training: The Department will maintain record of training for all current faculty, staff and students.

9.5 Medical Monitoring:

Medical monitoring is required whenever Environmental Health and Safety or the Chair of the Chemistry department ascertains a potential health risk to an employee due to work activities such as: noise levels, heat stress, biological hazards, chemical exposure and other subjective parameters. Employees who suffer a chance exposure to hazardous materials, chemical or biological, may request health monitoring.

10 **Administrative Controls & Responsibilities** (adopted by faculty vote March 2016)
Administrative Controls reduce or avoid exposure to a hazard through the use of policies, procedures, signage, training, and/or supervision. Under the OSHA *General Duty* clause, the employer has an obligation to recognize and control hazards, even those not addressed by a specific OSHA standard;[1] employees have an obligation to "comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct."

10.1 Department Chair
The department chair is ultimately responsible for all departmental safety issues. Specific responsibilities include:

Overseeing and enforcing compliance with all pertinent federal, state, and university guidelines related to safety and the safe use of hazardous materials;

Working with appropriate UNL offices (including, but not limited to Building Systems Management and the Office of Environmental Health and Safety) to establish and/or maintain appropriate engineering controls for operations within Hamilton Hall.

Acting as a liaison between the department faculty, the department safety committee and

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[1] **OSHA Act of 1970: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=3359&p_table=OSHACT**

the UNL administration on issues of safety.

Consulting with the safety chair on safety requirements for special events held in Hamilton.

Maintaining required documentation related to safety training, chemical inventories, and accident reporting.

Arranging medical monitoring for faculty and staff who are exposed to hazardous materials as part of their duties in Hamilton Hall.

Appointing and supervising the department Safety and Environment Committee.

10.2 Safety and Environment Committee

The vice-chair, the building manager, the general chemistry lab coordinator and the organic lab coordinator are standing members. The department chair will appoint additional faculty and staff members to terms of one to three years, and will appoint the chair of the committee who will typically also serve as the departmental Chemical Hygiene Officer. Co-Chairs in priority focus areas (for example, Chemical Hygiene, Hazardous Materials, Training) may be appointed if desired. Committee responsibilities include:

Implementing the departmental safety plan.

Instituting and coordinating departmental safety and hazardous materials training programs for faculty, staff, and research students. This includes supplementing university-wide procedures with information specific to Hamilton Hall, such as locations and sound of alarms, recommendations for specific emergencies, and recommended evacuation routes.

Acting as a liaison between the department and the UNL Office of Environmental Health and Safety.

Working with the Department Chair to coordinate safety requirements for special events held in Hamilton.

Monitoring compliance with guidelines for safe lab practices and ~~for the~~ safe use of hazardous materials; performing hazards assessments, as needed or requested; conducting laboratory inspections as requested or needed; reviewing laboratory-specific safety training and standard operating procedures, as needed or requested.

Serving as a resource for departmental faculty, staff members, and students to help resolve safety and environmental health issues.

Bringing safety and environmental health issues to the attention of the relevant faculty investigators and/or faculty or staff facility directors and working with those parties to help resolve the issue; elevating unresolved issues to the department Chair and Executive Committee. Situations or practices that have potential for serious injury or major property or environmental damage, may need to be reported to the UNL Office of Environmental Health and Safety.

Coordinating tests and drills (for example, fire drills) with UNL Facilities and other appropriate outside agencies (e.g., UNL Police, Lincoln Fire Department).

Investigation [and reporting] of accidents and incidents;

Reviewing and updating the Safety/Chemical Hygiene Plan at least annually.

10.3 Principal Investigators, Facility or Lab Managers, and Course Instructors (including principal investigators, lab managers, and course instructors for labs at the 200-level and above) are responsible for:

Instituting plans for a safe work place in research, teaching and service labs; creating, maintaining and promulgating a safety plan or equivalent document for the lab or facility.

Conducting [and documenting] any specialized safety training needed for the specific laboratory or facility.

Implementing safe lab and demonstration practices, including the use of appropriate personal protective equipment and/or engineering controls appropriate for the nature of the research, instructional lab activity, and demonstrations.

Monitoring and enforcing compliance with safe lab practices, including the performance of routine evaluations of safety hazards and/or non-conformance with regulatory requirements. These inspections must be conducted with a frequency that ensures "expedient" identification of hazards (adapted from: EHS Injury and Illness Prevention Plan, 2011).

Working with the departmental safety committee and departmental staff to ensure that laboratory personnel and/or students have taken appropriate departmental and university training, and are familiar with the departmental Safety/Chemical Hygiene Plan.

Ensuring the proper storage, handling and disposal of hazardous materials.

Maintaining an inventory of chemicals used in the laboratory or facility.

Reporting any accidents to the safety committee and the Department Chair.

Considering experience level when establishing the degree of independence allowed to researchers, students and visitors

10.4 Staff and student researchers/employees (includes technical staff and all researchers, including postdoctoral scientists, graduate and undergraduate assistants, staff scientists, and visiting researchers or interns)

Staff and Students (including graduate and undergraduate students) and any personnel conducting research in Hamilton Hall are responsible for:

Following procedures and guidelines described in campus and the departmental safety and/or chemical hygiene plans, and complying with all laboratory-specific safety plans or standard operating procedures.

Completing all required health, safety and environmental training (campus, departmental or lab specific) and conducting a hazard analysis (reviewing and understanding the hazards of materials and processes) prior to conducting research or any laboratory operations.

Understanding the capabilities and limitations of available personal protective equipment (for example but not limited to goggles/safety glasses gloves, etc.) and engineering controls (for example, but not limited to fume hoods, blast shields, etc.), particularly in the context of the hazards anticipated to be present in a particular operation.

Utilizing appropriate measures to control identified hazards, including but not limited to

familiarity with standard safety literature (e.g. safety data sheets), compliance with any administrative controls, and proper use of personal protective equipment and engineering controls.

Informing the PI/ Laboratory Supervisor of any work modifications ordered by a physician as a result of medical surveillance, an occupational injury, or exposure. Participating in the medical surveillance program, when required.

Maintaining a safe and uncluttered work and study area.

Reporting unsafe activities/conditions, accidents, or injuries to the supervisor or safety chair.

In addition, any laboratory personnel operating with significant independence (those whose level experience justifies work without continuous oversight) are responsible for:

Regularly updating the supervisor, and discussing in advance any deviations from agreed upon activities (either in scope or scale).

Performing hazard assessment and literature surveys relevant to safe conduct of the planned activities.

Taking steps to minimize safety risks (for example, minimizing the risk of working alone in a lab space by establishing a "buddy system" with students in a neighboring lab.)

When responsible for training less experienced students or researchers, either providing appropriate safety training and oversight or notifying the supervisor if additional training and oversight is required.

10.5 Teaching Assistants:

Teaching Assistants, who are charged with supervision of less experienced students in a classroom and/or laboratory setting, play a very important role in creating and maintaining a safe learning experience for students and have specific responsibilities for enforcing compliance with departmental and lab procedures, including:

student use of appropriate personal protective equipment;

Wearing of appropriate clothing; avoiding food and drink in the lab;

promoting and maintaining a professional atmosphere that does not include horseplay or harassment;

maintaining cleanliness;

and any other policies described in the lab syllabus, safety plan, or handouts.

Immediately reporting unsafe conditions to the lab coordinator/instructor.

Knowing the location of emergency/safety equipment (fire extinguisher, eye wash, safety shower, spill kit), being familiar with the use of this equipment, and notifying the lab coordinator/instructor of any deficiencies or problems with emergency/safety equipment.

In an emergency, taking charge of student safety until help arrives.

Ensuring the safety of lab students and their compliance with emergency procedures (for example, evacuation in the event of a fire alarm, fire, or major chemical spill).

In the event of a student accident or medical emergency (cut, burn, chemical exposure,

seizure), taking and delegating initial action (getting an injured student to an eye wash or emergency shower, contacting 911, sending a runner to the Resource Room for help).

Submitting, immediately, an injury report (to the Safety Chair and, if directed, to UNL Environmental Health and Safety) in the event a student is injured

10.6 Students taking classes in Hamilton Hall.

Students enrolled in chemistry courses are expected to comply with university, departmental, *and lab-specific safety and guidelines, including:*

Completing any safety readings, procedures, or training required by the specific class or lab;

Using appropriate personal protective equipment as described in safety handouts and/or in-lab training. Note that eye protection (goggles or approved safety glasses are <u>always</u> required unless the instructor has indicated differently).

Wearing appropriate clothing as described in lab handouts or training;

Keeping food and drink out of the lab;

Maintaining a professional atmosphere that does not include horseplay or harassment;

Maintaining a clean and orderly lab space and cooperating in maintaining the cleanliness of the teaching lab.

Bringing any unsafe conditions, including deficiencies or problems with emergency or safety equipment, to the attention of the lab coordinator/teaching assistant.

Being aware of escape routes from the lab and building in the event of an emergency;

Knowing the location of emergency/safety equipment (fire extinguisher, eye wash safety shower, spill kit) and being familiar with use of this equipment.